AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 20 DECEMBER, 1937 NUMBER 12

A COMPARATIVE STUDY OF EXPERIMENTAL AND CLINICAL EXOPHTHALMOS*

GEORGE K. SMELSER, PH.D.
New York

Exophthalmos associated with thyroid disease has long been a challenging problem. Understanding of the mechanism of this condition has been delayed by the difficulty in making careful studies of the orbital contents in cases of exophthalmos of varying severity, especially those of short duration. However, during the past eight to ten years many important studies of the retrobulbar tissue in such cases have been made.

Several theories have been offered to explain the proptosis associated with Graves's disease, including increased orbital fat, edema, muscle hypertrophy, dilatation of orbital vessels, and contraction of smooth muscle in the floor of the orbit. The last two postulates of a functional exophthalmos have not received strong support recently, though that they may be important factors in some cases has not been disproved. The idea that increased orbital fat is the cause of proptosis has also been little advocated of late, and it may be that earlier workers mistook edema and fibrosis of the retrobulbar tissue for increased fat. Histological studies of these tissues were seldom made. The reports of Burch,[2] Naffziger,[3, 4, 5] Wheeler,[6] and Thomas and Woods,[7] emphasize swelling of the extraocular muscle as the cause of exophthalmos. Increased size of these muscles seems to be due mainly to an edema, often accompanied by a cellular reaction. These reports do not necessarily conflict with the earlier ones by R. F. Moore,[8, 9] Thomson,[10] and others, who regard edema of the orbital connective tissue and fat as important, since they did not examine the muscles histologically, although their swollen condition was noted.

In general there is agreement that in exophthalmos the orbital tissues are strikingly modified by edema, cellular infiltration, and degeneration of many of the muscle fibers, and that, at least in the progressive postthyroidectomy type of exophthalmos, this condition is responsible for the protrusion.

Experimental approach to this problem has not often been made and production of definite exophthalmos similar to that found clinically has not been attained.

Slight exophthalmos resulting from sympathetic stimulation with drugs or electrical current has been well known for many years. MacCallum and Cornell,[11] and Code and Essex[12] demonstrated the protrusion to be due to contraction of smooth muscles found in the orbits of the species used. Cannon, Binger, and Fitz[13] produced some degree of exophthalmos through stimulation of the sympathetic nervous system by phrenico-sympathetic anastomosis.

* From the Institute of Ophthalmology, Columbia University. Read before the Association for Research in Ophthalmology, at Atlantic City, N.J., June 8, 1937. A preliminary report has been published.[1]

Transitory exophthalmos, probably dependent upon engorgement of the orbital vessels, may be induced in some strains of rabbits by administration of oxyquinoline sulphate (Miller and Taub[14]). About one-third of the rats fed a diet deficient in minerals develop a slight exophthalmos, according to Yudkin.[15] The orbital tissues were normal.

Edmunds[16] found that thyroidectomized monkeys were slightly enophthalmic but when fed thyroid substance developed a slight exophthalmos. Gley,[17] however, reported that thyroidectomy alone in rabbits induced an exophthalmos. Kunde[18] was unable to confirm Gley's work but reported that exophthalmos could be induced by feeding thyroid to thyroidectomized rabbits, but not to normal rabbits. Cameron[19] reports exophthalmos as a result of feeding thyroid to normal guinea pigs. In no case were orbital tissues studied nor was the exophthalmos marked.

Marine[20, 21] reported that administration of methyl cyanide, under certain conditions, produced thyroid hyperplasia and an exophthalmos in about half of the rabbits used. Feeding fresh vegetables or administering iodine prevented the exophthalmos. Males from three to four months old, of the Dutch breed, were most susceptible. Removal of the cervical sympathetic ganglion prevented the exophthalmos, demonstrating it to be due to sympathetic excitation. Exophthalmos was readily induced in thyroidectomized animals.

Schockaert,[22] Loeb,[23] Marine,[24, 21] and Friedgood[25] noted that in addition to marked thyroid enlargement and hyperplasia, exophthalmos resulted from administration of thyreotropic pituitary extracts and disappeared at death or under narcosis. Marine suggested that the same mechanism applied here as in cyanide exophthalmos, showing that it could be produced in thyroidectomized animals and prevented by removal of the cervical sympathetic ganglion. The exophthalmos appeared in only a portion of the animals, and considerable difficulty was met in measuring the degree of protrusion. No reports were made of the orbital tissues.

It is clear that a number of successful attempts have been made to produce exophthalmos experimentally. However, as Naffziger pointed out, a marked or progressive exophthalmos has not been produced similar to that found clinically. In analyzing the problem of exophthalmos, it is essential to hold in mind the characteristics of the clinical type and to check the experimental product against it by histological examination of the orbital tissues in each.

Clinical data

Biopsies of the orbital tissues in six cases of exophthalmos were studied.* Thyroidectomy had been performed in five of the cases (on four females and one male), and the sixth patient, a male, had a moderately high basal metabolism (plus 31 percent), unsuspected when the exophthalmos developed. Portions of the fat, connective tissue, and muscles were examined histologically in each case. The findings will be discussed as a group, since essentially the same condition was found in the tissues in all six cases.

In a number of instances fat, connective tissue, and muscle occurred in one section. The connective tissues were edematous. Following treatment with bichromate fixatives, the edema fluid became granular and shrunken. In those instances in which Bouin fixation was employed, the edema fluid appeared as a smooth matrix, stained with eosin or aniline blue, penetrating between the collagenous connec-

*I am deeply indebted to Drs. John M. Wheeler, T. H. Johnson, and D. B. Kirby for their coöperation in obtaining these tissues.

tive-tissue fibers and in some instances between fat cells which appeared to be isolated in an eosinophilic medium (see figures 9 and 11). Slender fibers were scattered throughout, giving the impression that as the fluid appeared in the connective tissue the fibers were dispersed and separated. In some regions solid masses of fat were found fairly free from ordinary connective tissue, and here there was little or no edema, though on the periphery of such areas the condition described above could be found.

Accompanying the edematous condition there was infiltration of wandering cells, positive identification of which was difficult; many of them seemed to be of embryonic nature. Distribution of these cells was uneven, numerous in some tissues and scarce in others obtained from the same orbit, making it impossible to generalize as to the condition of an entire orbit on the basis of a small fragment removed at operation (see figure 17). In several instances aggregations of these cells were found in rounded masses, frequently perivascular and resembling germinal centers, a condition previously described in extraocular muscles of such cases.

Muscle specimens are somewhat difficult to interpret, for it is hard to obtain satisfactory longitudinal sections, and muscle structure may be affected in varying degree by surgical handling.

Eleven pieces were removed in the six cases studied, including portions from the exterior rectus, inferior rectus, inferior oblique, superior rectus, and levator muscles. No opinion can be expressed regarding the size of the extraocular muscles in two cases; in one there was no enlargement, and in the other the enlargement was thought to be limited to a swelling of extramuscular tissue tightly adherent to it. The muscles were enlarged in two cases; one a hyperthyroid, and the other a postthyroidectomy, in which exophthalmos had developed since the operation.

Histologically the muscle specimens were quite uniform. The fibers of all were separated by an interstitial edema accompanied by a varying degree of round-cell infiltration (see figures 13 and 15). The edematous infiltrate was identical in staining properties and appearance with that found in the fat and connective tissues, and was in some sections continuous with it. In some preparations modification was so extreme that muscle fibers occupied less space than did the surrounding fluid; in others the edema was much less pronounced. All muscles of an orbit need not be equally affected. Wandering cells of various types were present in the muscles, but not in greater numbers than were found in fat and connective tissue.

Much prominence has been given to reports of degeneration of the extraocular muscles in exophthalmos. It is difficult to obtain thoroughly satisfactory preparations of several muscles made with different fixatives and stains in such cases as these; however, a number of the preparations studied were cut longitudinally, and with but few exceptions they possessed excellent striations. This does not imply that the degeneration described by Naffziger and others was not present, for a definite decision was made only on the basis of longitudinal sections.

The foregoing data in general confirm the observations of others who have studied similar material. Edema and wandering cells in the fat and connective tissue, as well as in the muscles, indicate a general reaction throughout the orbit, most striking in the muscles; since a definite rather than a diffuse tissue is involved.

Two cases deserve particular emphasis. In one, hyperthyroidism was discovered after the exophthalmos had become ex-

treme, and the biopsies were taken before any thyroid treatment had been administered. In the other, the exophthalmos developed after a subtotal thyroidectomy, although the basal metabolism was low. In both, the protrusion was great and the eye was lost because of corneal damage. The extraocular muscles in both cases were enlarged and the edematous and cellular infiltrates found in the muscles, connective tissue, and fat were histologically identical. These cases suggest that the mechanism of exophthalmos in hyper- and hypothyroidism is the same.

Experimental

The experimental work was carried out with several purposes in mind: to discover whether a true exophthalmos could be induced; to determine the mechanism of the protrusion; to investigate the role of the sympathetic nervous system; and to study the orbital tissues in comparison with those of clinical exophthalmos.

Approximately 100 young adult guinea pigs were used. Of these 50 were thyroidectomized and one cervical sympathetic ganglion removed in half of them. Both males and females were included, some of them gonadectomized. They were fed normal stock diet of hay, oats, and green vegetables.

The extract used was prepared from acetone-dried beef anterior pituitaries from which the posterior lobes had been carefully removed. The dry glands were powdered and repeatedly extracted with dilute aqueous NaOH. The gland substance was removed by centrifugation and the pooled extracts partially purified by iso-electric precipitation and centrifuging. The active principle in the clear supernatant was precipitated by the addition of flavianic acid.[26] The precipitate was dissolved and injected subcutaneously, the dosage based on the original dry anterior-pituitary equivalent. This preparation is nontoxic even when administered in large amounts, and contains a great deal of gonadotropic, thyreotropic, adrenotropic, and growth hormone activity. The control extracts of liver and thymus were prepared in the same way. An injection of 0.1 mgm. crystalline thyroxin was given daily as a further control.

Results

Thyroidectomy had no obvious effect on the eyes. Removal of the cervical sympathetic ganglion produced a definite ptosis, enophthalmos, and a small pupil in the affected eye. Injection of beef pituitary extract into normal guinea pigs produced no demonstrable effect, whereas in all but three of the thyroidectomized animals a definite, and in some instances an extreme exophthalmos was induced (figures 1 and 2).*

The eyes of the animals that received liver or thymus extracts remained quite normal throughout the experiment, while those receiving thyroxin became definitely enophthalmic.

Exophthalmos was usually noted in from 12 to 20 days after the first injection, though in one case it was not definitely established until after 53 days of injections, when it became extreme. The first indication of exophthalmos was usually a scleral band visible entirely around the cornea, followed by a flaring outward of the lids, particularly the upper, which assumes a puffy appearance. Normally the sclera of guinea pigs is visible only at the angles of the eye, the lids coming just to the limbus. In many instances the exophthalmos developed unilaterally, or one eye became more prominent than the other; however, both eyes eventually always became equally affected. The exophthalmos produced varied considerably in degree, although

* Photographs of the guinea pigs reproduced in this paper were by Adolf Marfaing.

FIG. 1

FIG. 2

Fig. 1 (Smelser). Normal guinea pig.
Fig. 2 (Smelser). Exophthalmic guinea pig with exophthalmos induced by daily subcutaneous injection of beef anterior-pituitary extract following thyroidectomy.

FIG. 3

FIG. 4

Fig. 3 (Smelser). Living exophthalmic guinea pig showing scleral band around the cornea.
Fig. 4 (Smelser). The same guinea pig as in figure 3, 20 to 30 minutes *post mortem*.

it was roughly proportional to the amount of pituitary extract given. Mild inflammation of the bulbar conjunctiva occurred in a few of the more advanced cases, and in one the upper conjunctival sac became partially everted and prolapsed through the palpebral fissure.

The exophthalmos herein described can be shown to be a true protrusion and not an apparent one due to retraction of the lids. By placing a small piece of silver on the cornea, the displacement of the bulb from the bony orbit was readily demonstrated in roentgenograms. This

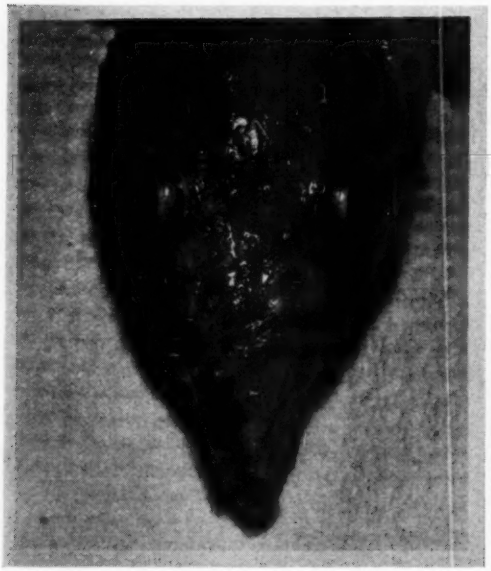

FIG. 5

FIG. 6

Fig. 5 (Smelser). Postmortem normal guinea pig with skin and lids removed.
Fig. 6 (Smelser). Postmortem exophthalmic guinea pig. Skin and lids have been removed to show that the protrusion is real relative to the skull and is not simply a "stare" due to smooth muscle acting on the lids.

FIG. 7

FIG. 8

Fig. 7 (Smelser). Postmortem normal guinea pig with skin and lids removed, profile view.
Fig. 8 (Smelser). Postmortem exophthalmic guinea pig demonstrating the exophthalmos in profile. The engorgement of the vessels on the globe was present during life and may be a reaction to exposure of the conjunctiva.

technique allowed accurate measurement of the exophthalmos by determining the distance of the foreign body from any structure in the skull shown on the X-ray plate. The exophthalmos did not disappear *post mortem* (figures 5, 6, 7, and 8), but in many instances became more marked as the lids relaxed (figures 3 and

4). This was particularly noticeable on the side from which the cervical sympathetics were removed.

Enophthalmos induced by the removal of the cervical sympathetic ganglion was converted into an exophthalmos by pituitary injections. This was readily noted by comparison with controls in which a similar operation was done, though with few exceptions the exophthalmos appeared to be slighter than in normally innervated eyes. At death the difference between such eyes and those with normal innervation disappeared and the exophthalmos was equal.

At autopsy the tissues of the orbit were carefully dissected and weighed. Fat and connective tissues in the orbits of the exophthalmic animals appeared to be edematous, whereas such tissues from animals treated with liver or thymus did not differ from those from the uninjected controls.

The average weights of the orbital tissues of experimental and exophthalmic control animals are given in table 1. The average total weight of the retrobulbar tissue of the exophthalmic animals was 34 percent greater than that of the controls, although the weight of the body and globe was greater in the normal series. An increase of one third of tissue in a confined space such as the orbit readily accounts for the exophthalmos *post mortem*, and in cases in which the cervical sympathetic ganglion had been removed. The increase in orbital-tissue weight was surprisingly specific; the fat, muscles, and one lacrimal gland were involved, whereas the second lacrimal, structurally distinct from the other, was not. The orbital fat was most markedly affected, increasing 2½ times over normal. The dorsal lacrimal, because of its size in the guinea pig, was an important factor. The muscle hypertrophy of 23 percent was particularly significant because of the consistent weight of the muscles in the controls, none of which exceeded the normal. A study of the individual cases suggests that this tissue reacts slowly, the larger muscles occurring after longer treatment.

Orbital tissues obtained from eyes affected by ablation of the cervical sympa-

TABLE I

AVERAGE WEIGHT OF ORBITAL TISSUES

Number of Cases	Treatment	Body Wt. gm.	Globe mgm.	Orbital Fat mgm.	Dorsal Lacrimal mgm.	Ventral Lacrimal mgm.	Extra-ocular Muscles mgm.	Total Retro-bulbar Tissues mgm.
6	Normal No injection	473	491	24.4	344	215	81.0	665
8	Thyroidectomized, no injection	508	473	33.1	373	219	77.2	655
5	Thyroidectomized, thymus extract injected	392	472	33.1	338	191	79.8	642
6	Thyroidectomized, liver extract injected	411	466	27.3	311	183	81.1	603
19	Thyroidectomized, anterior pituitary extract injected	479	483	62.7	521	209	100.1	893

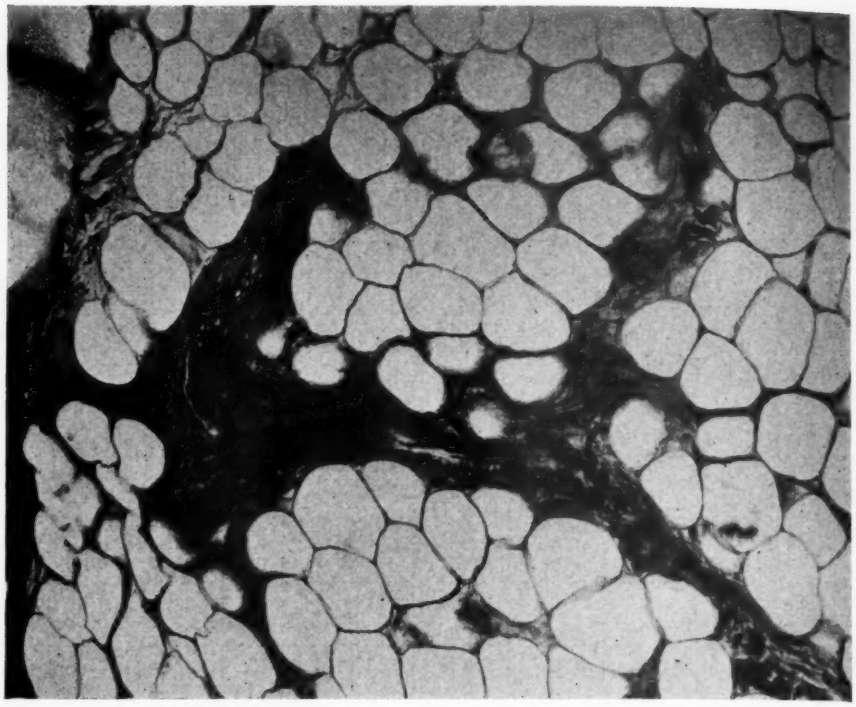

Fig. 9 (Smelser). Normal human orbital fat. × 170.

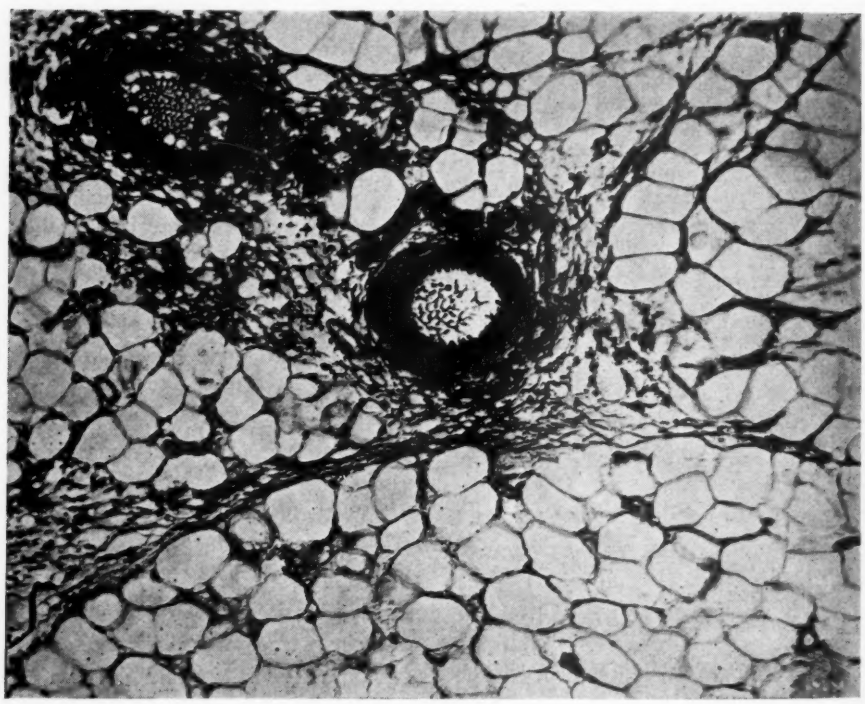

Fig. 10 (Smelser). Photomicrograph of orbital fat from a normal guinea pig, showing a region particularly rich in connective tissue. × 170.

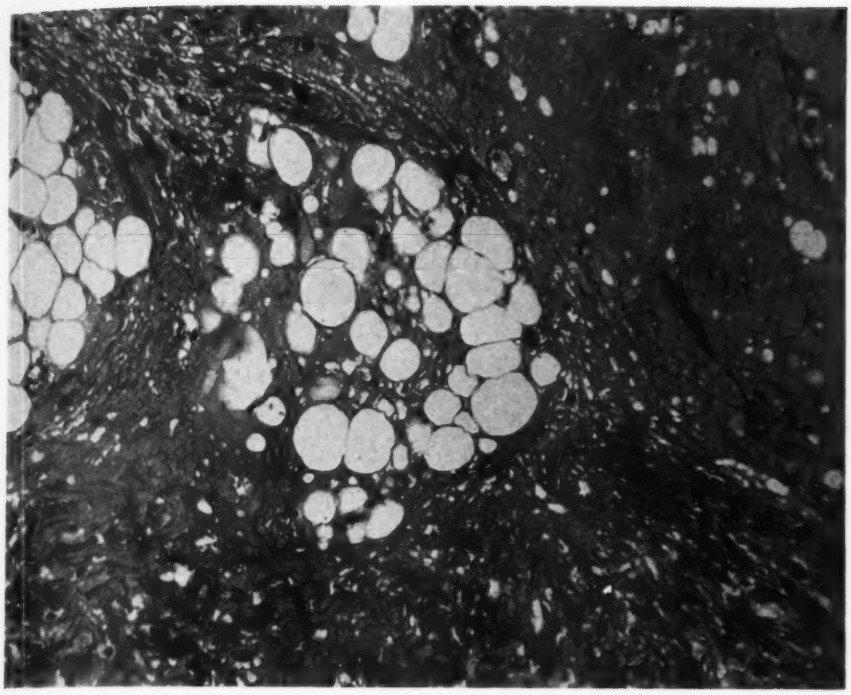

Fig. 11 (Smelser). Section of orbital fat and connective tissue of exophthalmic human. Note the marked edematous infiltration, similar to that found in the ocular muscles, of both fat and connective tissue. Round cells are scattered throughout the section. × 170.

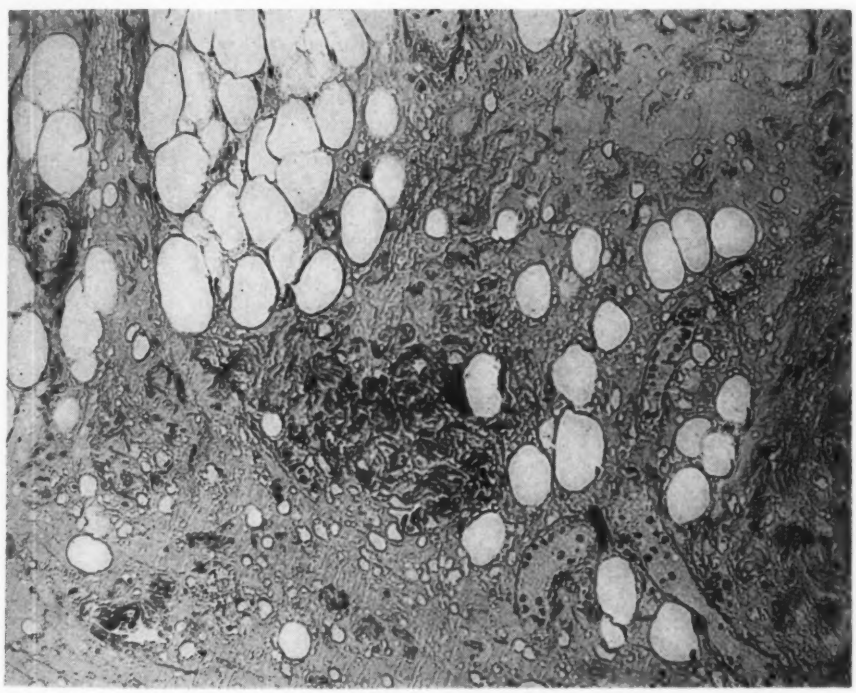

Fig. 12 (Smelser). Section of orbital fat and connective tissue of an exophthalmic guinea pig. Demonstrating the edematous infiltration produced experimentally. The animal had been thyroidectomized and injected with an extract of beef anterior-pituitary gland. × 170.

Fig. 13 (Smelser). Normal human ocular muscle. × 170.

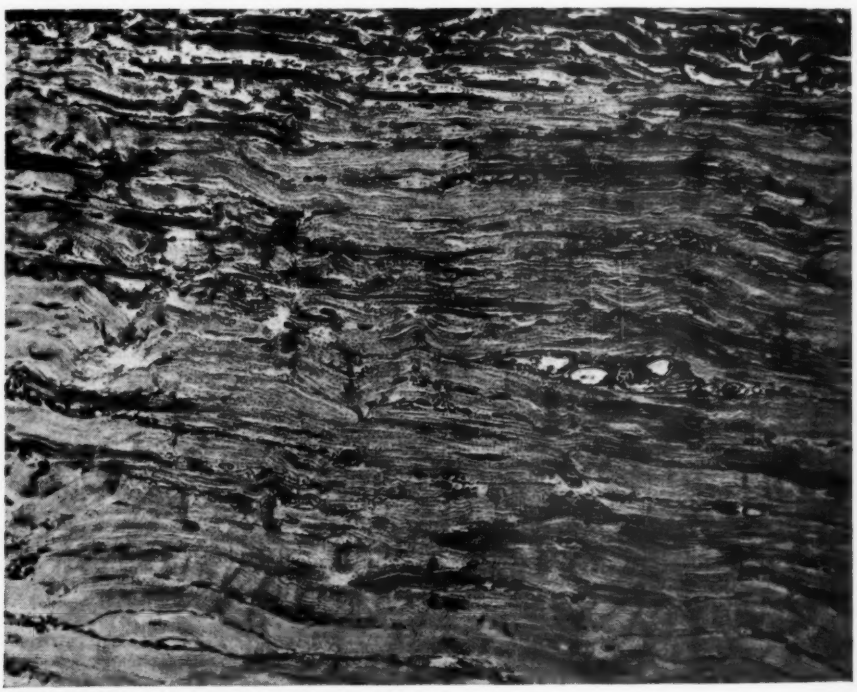

Fig. 14 (Smelser). Normal guinea-pig ocular muscle. × 170.

Fig. 15 (Smelser). Section of an ocular muscle of an exophthalmic human. This specimen is from a case of marked exophthalmos which increased in severity following a subtotal thyroidectomy for exophthalmic goiter. Note the edema and round-cell infiltration. × 170.

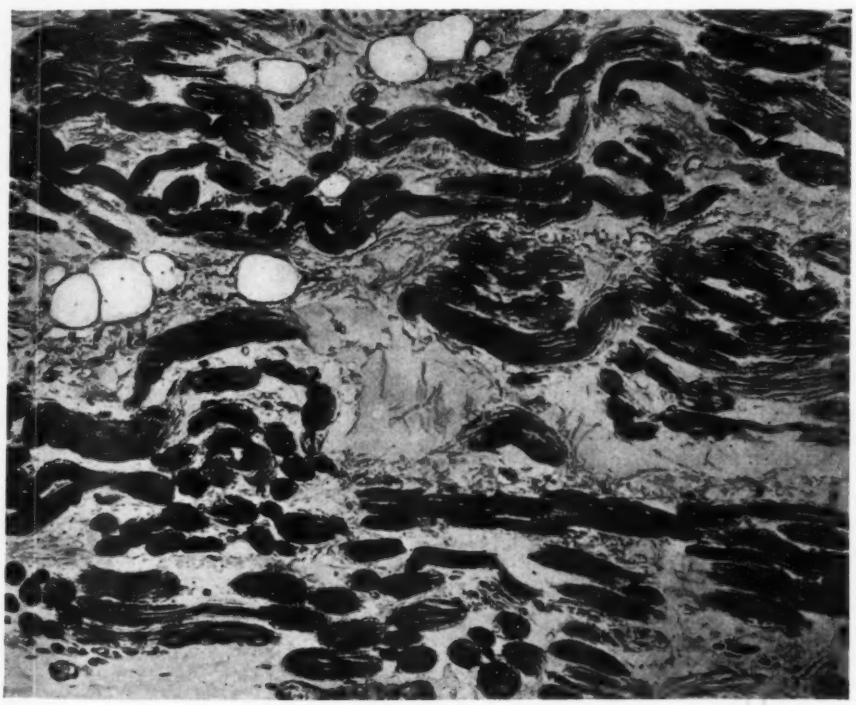

Fig. 16 (Smelser). Section of ocular muscle of an exophthalmic guinea pig. The animal was thyroidectomized and injected with an extract of beef anterior pituitary. Note the edematous infiltration. × 170.

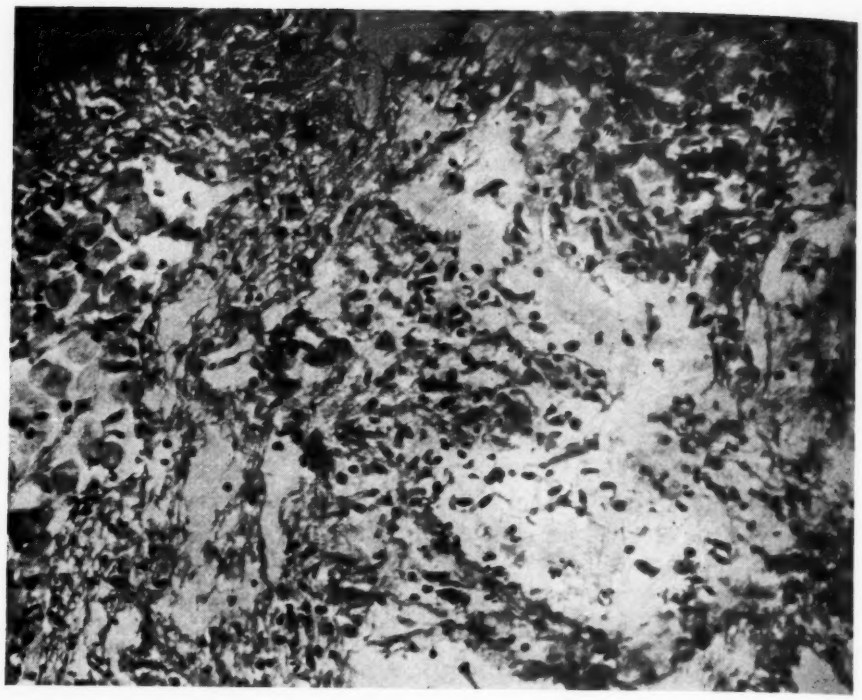

Fig. 17 (Smelser). Section showing wandering-cell invasion of orbital tissue of an exophthalmic human. Same case as in figure 15.

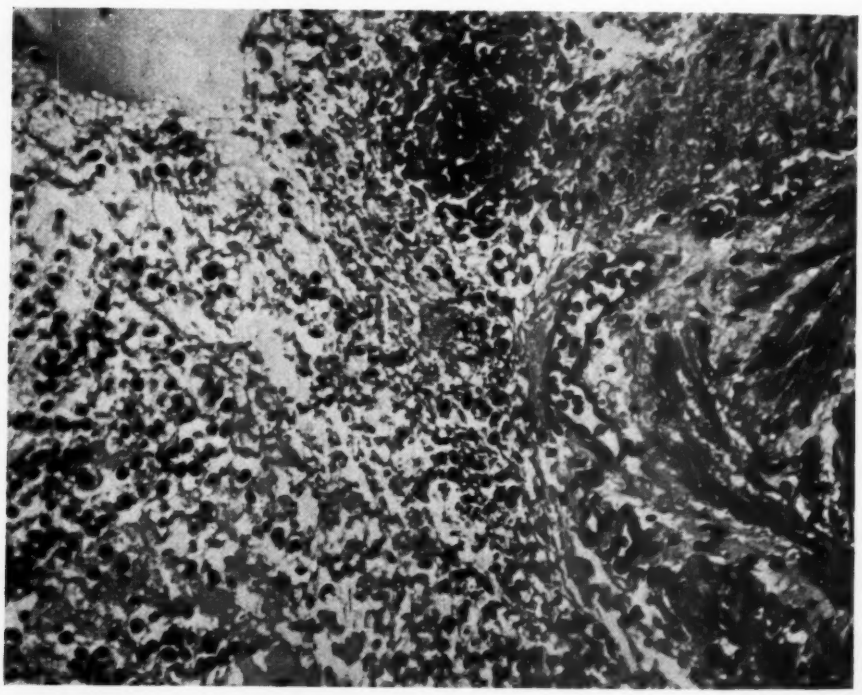

Fig. 18 (Smelser). Section showing wandering cells in orbital tissue of an exophthalmic guinea pig. The dense aggregation shown is characteristic of orbital tissues of clinical exophthalmos.

thetic ganglion were identical with those from eyes with normal innervation. Nine cases of exophthalmos were available in which the left cervical sympathetic ganglion had been removed, thus allowing comparison within an individual of the effect of this operation. The total retrobulbar tissue of the right eye was 895.5 mgm., and of the left 905.8 mgm. Extirpation of this ganglion does not affect the weight of normal orbital tissues nor does it affect the increase of these tissues in experimental exophthalmos.

Histology

The structure of the orbital tissues, particularly the fat, was strikingly modified by a stainable edematous infiltrate which was found between the fat cells and collagenous connective-tissue fibers (figure 12). In Bouin-fixed preparations it was strongly stained with eosin or aniline blue and contained granules and droplets. It was granular and shrunken following the use of bichromate fixatives. This edema fluid penetrated between the muscle fibers, particularly in regions rich in connective tissue, but was less in evidence than in the fat (figure 16).

Throughout the edematous material were many lymphocytes which in some cases were present in large numbers in a rather restricted region similar to that found in the orbital tissues from patients with exophthalmos (figures 17 and 18). Aggregations of these cells also occurred in the muscles, usually associated with edema and blood vessels.

It was possible to obtain excellent sections of the extraocular muscles in all of these cases, cut longitudinally, stained by several methods, and passing through the entire length of the muscle. Practically all of the muscle fibers were normal histologically, and striations were demonstrable in the most extreme cases.

Orbital tissues from the control groups did not exhibit the changes described above (figures 10 and 14). Small amounts, however, of a material similar to the edematous infiltrate found in exophthalmic animals may be found in the fat of normal and thyroidectomized controls.

Discussion

The clinical cases discussed here agree with both the muscle-hypertrophy and edema theories, indicating a general response of all orbital tissue rather than a specific reaction of one.

The edema tends to accumulate in the connective tissue, which seems to be increased in amount and to pervade all parts of the orbit. Close association of the edema and connective tissue was emphasized by finding in some biopsies regions in which there was much less connective tissue, areas of almost pure fat or solid muscle fibers, relatively free from edema. At operation the connective tissue about the muscles and Tenon's capsule was found to be hypertrophied, giving the impression of "newly formed" tissue, rubbery in texture, which proved to be edematous.

Degeneration of muscle fibers reported by others was not striking in the preparations studied. This may be partly due to the relative scarcity of suitable material, though one must conclude that there are many normal muscle fibers in such cases. If muscle degeneration does not occur invariably in exophthalmos, it may be a secondary effect caused by mechanical or toxic factors due to lowered tissue nutrition.

It is difficult to say whether the orbital changes described cause the exophthalmos or are themselves the result of the protrusion. Many of the studies reported have dealt with long-standing conditions in which secondary changes may be suspected. In the present series one patient was operated on only a few months after

the onset of exophthalmos, and exhibited all changes found in the others. Reports of characteristic modification of orbital tissue following enucleation support the idea that the condition described is responsible for the exophthalmos.

Although severe progressive exophthalmos has been associated with postthyroidectomy hypothyroidism, a similar mechanism is indicated in the present study as responsible for exophthalmos in hyperthyroidism as well. However, there may be cases due to a different mechanism, possibly sympathetic excitation. These two types could conceivably occur together in hyperthyroidism, or one may succeed the other, The anatomy of the orbit seems to preclude a severe exophthalmos due to sympathetic stimulation.

The experimental exophthalmos reported here closely reproduces the clinical type, though several minor differences may be noted. The extraocular muscles were less affected than in the human, and the fat and connective tissue more so; this may be due to accurate measurements of fat and muscle in the experimental cases, impossible except at autopsy in the human. Far less connective tissue was normally found in the guinea-pig orbit than in the human. Exophthalmos was not accompanied by muscle degeneration in the guinea pig, nor was it necessarily found in all human cases.

As in clinical cases, however, the exophthalmos was due to increased orbital tissue. This hypertrophy, as in the human, includes fat, connective tissue, and muscles. Removal of the cervical sympathetic ganglion does not prevent exophthalmos clinically, nor did it prevent protrusion or tissue modifications in the exophthalmic guinea pig.

Marked edema of the orbital tissues characterizes both clinical and experimental exophthalmos, and round-cell invasion of the orbital tissues accompanies the edematous condition in both types, though more pronouncedly in the human.

The preponderance of similarities between the clinical and experimental exophthalmos herein described seems to justify the conclusion that the essential features of the clinical type have been reproduced. Further analysis is necessary to establish the identity of the mechanism involved.

Summary

Clinical

1. Exophthalmos in the cases studied was due to excess orbital tissue.
2. Retrobulbar connective tissue, fat, and muscles were edematous and infiltrated with wandering cells.
3. Similar changes were found in hyper and hypothyroid cases.
4. Extraocular muscles were enlarged, though muscle-fiber degeneration was not striking.

Experimental

1. Exophthalmos due to increased orbital tissue was produced in thyroidectomized guinea pigs.
2. Retrobulbar connective tissue, fat, and muscles were infiltrated with edematous material indistinguishable from that in clinical cases.
3. Exophthalmos persisted *post mortem*.
4. Removal of the cervical sympathetic ganglion did not inhibit the increase in orbital tissues.
5. Areas of round-cell infiltration were found in the fat and muscles.

References

[1] Smelser, G. K. Proc. Soc. Exp. Biol. and Med., 1936, v. 35, p. 128.
[2] Burch, F. E. Minn. Med., 1929, v. 12, p. 668.

[3] Naffziger, H. Ann. Surg., 1931, v. 94, p. 582.
[4] Naffziger, H., and Jones, O. W. Jour. Amer. Med. Assoc., 1932, v. 99, p. 638.
[5] Naffziger, H. Arch. of Ophth., 1933, v. 9, p. 1.
[6] Wheeler, J. M. Amer. Jour. Ophth., 1934, v. 17, p. 683.
[7] Thomas, H. M., and Woods, A. C. Johns Hopkins Hosp. Bull., 1936, v. 59, p. 99.
[8] Moore, R. F. Lancet, 1920, v. 2, p. 701.
[9] ——— Trans. Ophth. Soc. U. Kingdom, 1923, v. 43, p. 215.
[10] Thomson, E. S. Amer. Jour. Ophth., 1924, v. 7, p. 27.
[11] MacCallum, W. G., and Cornell, W. B. Med. News, 1904, v. 85, p. 732.
[12] Code, C. F., and Essex, H. E. Amer. Jour. Ophth., 1935, v. 18, p. 1123.
[13] Cannon, W. B., Binger, C. A. L., and Fitz, R. Amer. Jour. Physiol., 1915, v. 36, p. 363.
[14] Miller, H. R., and Taub, H. Proc. Soc. Exp. Biol. and Med., 1935, v. 32, p. 1207.
[15] Yudkin, A. M. Arch. of Path., 1934, v. 17, p. 40.
[16] Edmunds, W. Trans. Ophth. Soc. U. Kingdom, 1900, v. 20, p. 243.
[17] Gley, E. Compt. rend. de Soc. de Biol., 1910, v. 68, p. 858.
[18] Kunde, M. M. Amer. Jour. Physiol., 1929, v. 82, p. 195.
[19] Cameron, G. R., and Amies, A. B. P. Austral. Jour. Exp. Biol. & Med. Sci., 1926, v. 3, p. 37.
[20] Marine, D., Spence, A. W., and Cipra, A. Proc. Soc. Exp. Biol. and Med., 1932, v. 29, p. 822.
[21] Marine, D., and Rosen, S. H. Amer. Jour. Med. Sci., 1934, v. 188, p. 565.
[22] Schockaert, J. A. Amer. Jour. Anat., 1932, v. 49, p. 379.
[23] Loeb, L., and Friedman, H. Proc. Soc. Exp. Biol. and Med., 1932, v. 29, p. 648.
[24] Marine, D., and Rosen, S. H. Proc. Soc. Exp. Biol. and Med., 1933, v. 30, p. 901.
[25] Friedgood, H. B. Bull. Johns Hopkins Hosp., 1934, v. 54, p. 48.
[26] Evans, H. M., Meyer, K., and Simpson, M. E. Mem. Univ. Calif., 1933, v. 11.

THE EFFECTS OF ANOXEMIA ON OCULAR MOVEMENTS WHILE READING*

With especial reference to patients with motor anomalies

Ross A. McFarland, Ph.D., Charles A. Knehr, M.A., and Conrad Berens, M.D.
New York

Experiments conducted during mountain expeditions, ascents to high altitude by aeroplane and balloon, as well as in simulated high altitude in chambers at sea level indicate that a marked variation in the oxygen saturation of the arterial blood produces striking effects on the central nervous system. As one rises above the level of the sea, the pressure of the atmosphere falls (barometric pressure) and there are corresponding changes in the alveolar oxygen and carbon dioxide and in the oxygen saturation of the arterial blood. The curves in figure 1 summarize these changes based upon data from various studies at high altitude. The atmospheric changes that occur at high altitude can be duplicated in a low-pressure chamber at sea level. Since numerous experiments have shown that most of the organic changes at high altitude are related to oxygen want or to the diminished partial pressure of oxygen, the essential changes can also be reproduced in a low-oxygen chamber where the percentage of oxygen is lowered by replacing it with nitrogen.†

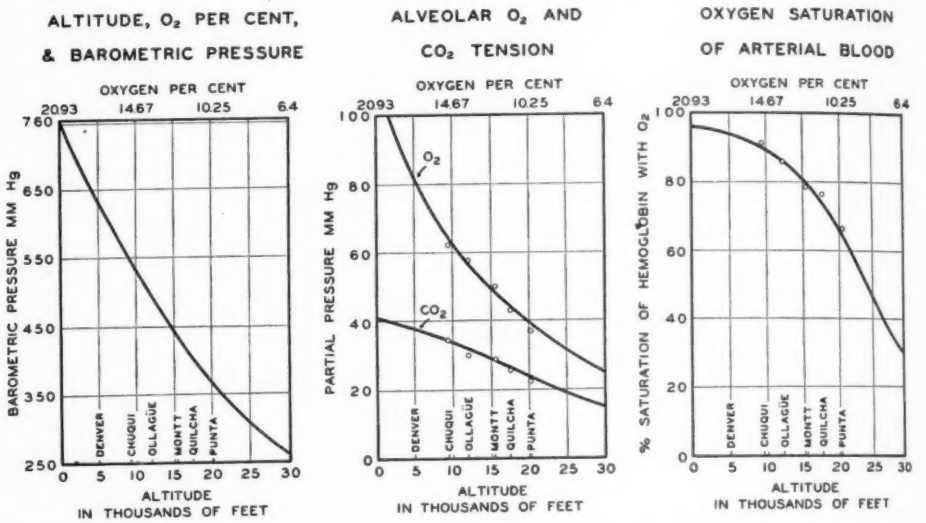
ALTITUDE, O₂ PER CENT, & BAROMETRIC PRESSURE
OXYGEN PER CENT
2093 1467 1025 64
BAROMETRIC PRESSURE MM Hg
760 650 550 450 350 250
DENVER CHUQUI OLLAGÜE MONTT QUILCHA PUNTA
0 5 10 15 20 25 30
ALTITUDE IN THOUSANDS OF FEET
ALVEOLAR O₂ AND CO₂ TENSION
OXYGEN PER CENT
2093 1467 1025 64
PARTIAL PRESSURE MM Hg
100 80 60 40 20 0
O₂
CO₂
DENVER CHUQUI OLLAGÜE MONTT QUILCHA PUNTA
0 5 10 15 20 25 30
ALTITUDE IN THOUSANDS OF FEET
OXYGEN SATURATION OF ARTERIAL BLOOD
OXYGEN PER CENT
2093 1467 1025 64
% SATURATION OF HEMOGLOBIN WITH O₂
100 80 60 40 20 0
DENVER CHUQUI OLLAGÜE MONTT QUILCHA PUNTA
0 5 10 15 20 25 30
ALTITUDE IN THOUSANDS OF FEET

Fig. 1 (McFarland, Knehr, and Berens). These curves show the barometric pressure, the alveolar O_2 and CO_2 tension, and the arterial oxygen saturation in relation to altitude based upon data from various studies at high altitude. The circles represent data from the Chilean Expedition[18] at the stations indicated. Reprinted from the Journal of Comparative Psychology, 1937, v. 23, Feb., no. 1, p. 193.

* Read before the American Association for Research in Ophthalmology, at Atlantic City, June 8, 1937.

† For a complete discussion of the physiological effects of high altitude cf. Barcroft, J. Lessons from high altitude. Cambridge University Press, 1936; Loewy, A. Physiologie des Hohenklimas. Berlin, Springer, 1932; Haldane, J. S., and Priestley, J. G., Respiration. Ed. 2. New Haven, Yale University Press, 1935.

Individuals differ greatly in their ability to become adapted to diminished partial pressures of oxygen. The degree of the disturbance and the extent of the compensatory adjustments depend primarily upon (1) the rate of the ascent, (2) the height attained, (3) the length of the exposure, and (4) the physical condition of the individual. At 12,000 feet the average subject may be only slightly impaired in most psychological functions. At 18,000 feet, however, where the barometric pressure is only one half as great as at sea level or where a given breath of air contains only one half as much oxygen (10.5 percent O_2), the effects may be quite marked. The nervous tissue appears to be particularly sensitive to oxygen deprivation. First, slight tremors and motor incoördination may be manifested; then impairment of judgment and memory, and emotional instability; and finally impairment of the special senses. A complete summary of the psychological changes associated with anoxemia has been made by McFarland.[9]

A number of studies have demonstrated the effects of oxygen deprivation on visual functions. During the World War, Wilmer and Berens[18] found that pilots (studied on the rebreather apparatus and in the low-pressure chamber) showed loss of visual acuity, constriction of visual fields, reduction in retinal sensitivity, changes in the heterophorias, and increased fatigability of the muscles of accommodation and convergence. These variations were only slightly apparent at 10,000 feet; quite pronounced at 15,000 feet; and very marked at 20,000 feet, especially if the experiment was prolonged over a two-hour period. Somewhat similar results were reported by Goldmann and Schubert.[7] After experimenting with a Douglas bag, Gellhorn and Spiesman[6] reported a lengthening of the latent period of negative afterimages, a loss of visual intensity and of discrimination, and the presence of nystagmus 10 to 30 minutes following the inhalation of a mixture containing from 11- to 9-percent oxygen (or 17,000 to 22,000 feet). Similar changes were also brought about by breathing 4- to 7-percent carbon dioxide and after voluntary hyperpnea lasting two to five minutes. In a recent expedition to the Chilean Andes (see figure 1 for various stations) McFarland[10] observed an increased fatigability in accommodation and convergence along with a change in the heterophorias (usually in the direction of divergence) and variations in the negative afterimage, as compared with control studies at sea level. In these acclimatized subjects the effects were only slight at 15,440 feet, but the impairment became fairly accentuated at 17,500 feet and 20,140 feet (fig. 1).

In a previous investigation the authors[12] analyzed the effects of diminished oxygen on the highly complex and delicate ocular movements during reading in subjects with visual acuity and muscle balance within the normal range. It was believed that the measurement of these reactions might serve as a sensitive test of the effects of O_2 want on the nervous system. The object of the study, therefore, was to investigate not only the effects of anoxemia on an unconscious and well-established motor habit but also to study the basic mechanisms involved in reading while these processes were retarded, for some of these mechanisms were unobservable with the usual procedures. The present study was carried out so as to compare these observations on subjects with normal visual acuity and muscle balance with those suffering from excessive heterophorias and even heterotropias combined with lowered visual acuity.

The actual character of the movement

TABLE 1

TABULAR SUMMARY OF OPHTHALMOLOGICAL EXAMINATION OF EXPERIMENTAL GROUP*

Case No.	Visual Acuity		Phoria in Prism Diopters								Prism Vergence				Pc.	P. P. of Accommodation mm.		Remarks
			6 m.				25 cm.				6 m.		25 cm.					
	R	L	E	X	HR	HL	E	X	HR	HL	Div.	Con.	Div.	Con.		R	L	
1	20/40−2	20/70−1	6					0			6	15	8	15	112	100/300	130/300	Conjunctiva congested. Tension normal. Left blind spot enlarged. No aniseikonia. Relative scotoma for form (5°) L.E. Refraction: R. −.37 D. sph. ⊂ +.75 D. Cyl. ax. 85° = 20/20 L. +.62 D. sph. ⊂ −.75 D. Cyl. ax. 70° = 20/40−2
2	20/15	20/15	1			4		8		4	5	10	2	10	135	125/300	120/300	External and ophthalmoscopic examination normal. Tension normal. Paresis right superior rectus and spasm left inferior oblique. Blurring and diplopia after reading. No aniseikonia. Refraction: R. Plano ⊂ $1\frac{1}{2}^{\Delta}$ base up. L. Plano ⊂ 1^{Δ} base down.
3	20/20	20/20	2					10			10	6	6	5	Remote	80/300	90/300	Alternating esotropia. Poor vergence. Aniseikonia. Retroplacement of both medial recti (4 mm.) 3 years before test. Refraction: R. +1.00 D. sph. L. +1.00 D. sph.
4	20/50+3	20/20		3		2		5		2	5	25	8	30	35	150/800	140/300	Exophoria with left hyperphoria. Refraction: R. −1.00 D. sph. ⊂ +5.00 D. cyl. ax. 104° = 2^{Δ} base up. L. + .50 D. sph. ⊂ 2.25 D. cyl. ax. 108° = 2 base down
5	20/40+3	20/30	ET 20		$1\frac{1}{2}$		ET 20				No amplitude of fusion.				55	80/300	70/300	Alternating esotropia. Abnormal retinal correspondence. Simultaneous macular perception only. (1936) Double recession O.U. Resection inferior rectus R.E. No prescription for lenses.
6	20/15	20/15		$13\frac{1}{2}$				10			16	120	18	5	90	110/300	108/300	Divergence excess. No prescription for lenses.
7	20/30	20/30		5				15				10		25		150/300	150/400	Operated on (1925) for exotropia O.U. Refraction: R. +1.50 D. sph. ⊂ +1.75 D. cyl. ax. 20° = 20/30 O.U. 20/25 L. +1.50 D. sph. ⊂ +1.25 D. cyl. ax. 170° = 20/30
8	20/70+2	5/500													200	110/300		Horizontal optic nystagmus. Optic atrophy, L.E. No muscle balance recorded due to poor fixation. Accident caused reduction in vision of L.E. Refraction: R. −4.50 D. sph. ⊂ −1.00 D. cyl. ax. 10° = 20/70 L. −3.00 D. sph. ⊂ −.50 D. cyl. ax. 180° = 5/500
9	20/15	20/15	3					2			3	20	10	25		100/300	100/300	Periodic alternating esotropia (formerly constant) apparently improved by orthoptic treatment. Refraction: R. +.25 D. sph. 3^{Δ} base out. L. +.25 D. sph. 3^{Δ} base out.

10	20/20	20/20−3	XT 2					XT 13			10	15	20	10	150	80/300	60/300	Exophoria—convergence insufficiency. Refraction: R. +.50 D. sph. ⊂ +.25 D. cyl. ax. 180° L. +.37 D. sph. ⊂ +.25 D. cyl. ax. 180°
11	20/30−1	20/30−1	0					5			5	10	10	20	100	100/300	100/300	Slight convergence insufficiency. Refraction: R. −1.50 D. sph. L. −1.25 D. sph.
12	20/15	20/15		8				15			8	90	10	66+	60	290/400	320/300	Divergence excess. Retroplacement lat. rectus 2.5 mm. three months before test. Iseikonic correction.

* Key to abbreviations: E, esophoria; X, exophoria; ET, esotropia; XT, exotropia; HR, right hyperphoria; HL, left hyperphoria; Div., divergence; Con., convergence; Pc, near point of convergence; P.P., near point of accommodation.

TABLE 2

Tabular summary of ophthalmological examination of control group*

Case No.	Visual Acuity		Phoria in Prism Diopters								Prism Vergence				Pc.	P.P. of Accommodation mm.		Remarks
			6 m.				25 cm.				6 m.		25 cm.					
	R	L	E	X	HR	HL	E	X	HR	HL	Div.	Con.	Div.	Con.		R	L	
13	20/15−1	20/15−1	0					2			10	15	15	15	60	140/200	140/200	Ophthalmoscopic and external examination normal. Fusion normal. No prescription for glasses.
14	20/20	20/15	0					3–5			5	15	10	65	40	110/300	120/300	Ophthalmoscopic and external examination normal. Tension normal. Slight convergence excess for near. Slight astigmatism O.U. No glasses ordered.
15	20/20−1	20/20	0					0			6	20	16	35	50	120/300	120/300	Ophthalmoscopic and external examination normal. Slight convergence excess for near. No glasses ordered.
16	20/30−2	20/15	1					2			6	15	10	25	80	125/300	95/300	Ophthalmoscopic examination normal. Tension Normal. Migraine. No glasses ordered.
17	20/15	20/15	1					1			6	20	8	15	120	110/300	80/300	Ophthalmoscopic examination and tension normal. Some follicular conjunctivitis.
18	20/25−1	20/20−3	0					4–6			4	12	10	15	45	90/300	100/300	Ophthalmoscopic examination and tension normal. Mild conjunctivitis. No glasses ordered.
19	20/20−3	20/20−3	1					0			8	15	2	12	60	120/300	120/300	Ophthalmoscopic examination and tension normal. Follicular conjunctivitis. No glasses ordered.
20	20/20−3	20/15−4	0					5			6				65			Ophthalmoscopic examination and tension normal. Refraction: R. −0.25 D. sph. ⊂ −0.75 D. cyl. ax. 180° = 20/15−1 L. −0.62 D. cyl. ax. 180° = 20/15−1

* See footnote, Table 1.

of the eyes in reading seems to have been first observed by Javal in 1878.[8] He noted that the eyes did not glide smoothly over the printed line but made a succession of pauses which he was able to count. Interest first centered in observing more precisely the actual performance of the eyes during reading. Later these movements were recorded mechanically or photographically from actual attachments to the eyelid or cornea. From the work of Erdman and Dodge, and Dearborn and Huey came the method of photographing the reflection of a point of light from the eccentric curvature of the cornea on a moving film. More recently this technique has been refined so as to measure the vertical as well as the horizontal components. In addition, adequate timing devices have been introduced and the photographic procedures simplified. A number of investigations have shown that reading before the camera gives reliable samples of typical reading performance.[15] The widespread interest in reading disabilities gave rise to a demand for simplified eye-movement cameras, which are now available. All phases of the problem of eye movements in reading have been discussed by Tinker,[16] Taylor,[13] and Vernon.[17]

Dodge and Benedict[5] studied the effects of alcohol on the ocular movements involved in fixating, as rapidly as possible, typewritten letters exposed in any one of six positions. They found that 30 c.c. of alcohol seemed to decrease the latency of the eye movements, while 45 c.c. increased it. When fixating two letters alternately, as fast as possible, there was a decrease in speed of 2.5 percent with 30 c.c. of alcohol and 18 percent following the ingestion of 45 c.c. Scofield[14] has recently reported a study of the effects of small amounts of alcohol and caffeine on optic nystagmus (Dodge mirror-recording technique). The pursuit movements were shortened and in some cases they disappeared, especially with the larger amounts of alcohol. The organism apparently more readily abandons the attempt to adjust when alcohol has been ingested than under normal conditions.

The use of reduced oxygen concentrations to bring about alterations in the internal environment is more direct and basic than that of alcohol, since nervous functioning depends upon an adequate oxygen supply. McFarland and Barach[11] and others have shown that the effects of alcohol are somewhat similar to those of oxygen deprivation, since alcohol suppresses oxidation, especially in the nervous tissues. The method of oxygen deprivation tends to minimize the psychological effects in as much as the concentrations of oxygen can easily be changed unknown to the subject.

Experimental procedure

The experimental group consisted of 12 patients whose diagnoses included refractive errors, muscle imbalance, and heterotropias (table 1). There were 8 patients in the control group with refraction and muscle balance within the normal range as shown in table 2. The age range of all patients was from 10 to 40 years.

The research was carried out in a Barach[2] oxygen chamber ($7 \times 8 \times 8$ ft.) in which the partial pressures of the gases as well as the temperature and humidity may be controlled. Figure 1 shows the relation between barometric pressure, altitude, and oxygen partial pressure as percentage of total sea-level pressure. The percentages of O_2 and CO_2 were frequently checked during the experiment; the CO_2 never exceeded 0.7 percent.

The general procedure was as follows: Each patient was tested under control

conditions corresponding to those at sea level. The control group and two experimental patients were tested at two altitudes (13,500 feet and 18,000 feet—12.5- and 10.5-percent O_2 respectively). The remaining 10 experimental patients were tested at sea level and at one altitude, ranging from 10,000 to 18,000 feet (14- to 10.5-percent O_2) depending upon the physical condition of the patient. The mean altitude for this group was approximately 15,000 feet (11.5-percent O_2). The patients in both groups read from three to six paragraphs, eight lines in length, before the camera. No reading was allowed between the tests while in the chamber. In addition, the patients in the experimental group were photographed while fixating a test object.

The apparatus used for photographing the eye movements was the Ophthalmograph.* This apparatus involves the photographing of the corneal reflections from the two eyes on a moving strip of motion-picture film.[1, 13] The eye-movement photographs were enlarged 20 diameters by projection upon a screen ruled so that a distance of two centimeters on the screen corresponded to one millimeter on the film. In projecting the records one eye track was centered on the zero line of the screen and the distance to the other track was measured directly. In this study more than 20,000 measurements were made from the photographic records. The error of measurement probably did not exceed 2 percent.

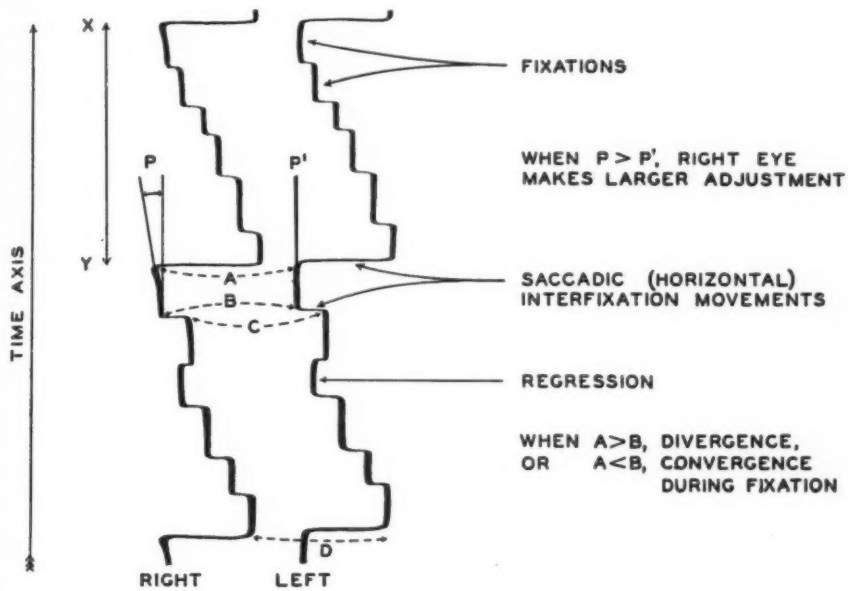

Fig. 2 (McFarland, Knehr, and Berens). Diagrammatic section of an eye-movement photograph.

The data from the eye-movement records, as well as the method of measuring them, are explained below and illustrated diagrammatically on a section of a control-patient's record (fig. 2):

1. The average time for reading six lines. (2.54 cm. of record equals two seconds.)

2. The average number of fixations per line. In the figure there are six fixations or pauses for perception on the

*Manufactured by the American Optical Company.

line. The movements between these successive pauses are known as saccadic movements.

3. The average number of regressions per line. A regression is shown in line 2 and represents a backward movement of the eye; as, for example, in attempting to get the meaning which has been missed.

4. The line deviation. This is the difference between the position of the eyes relative to each other from the beginning to the end of a single line.

5. Average binocular deviation during fixations. These are changes in vergence that take place during the time of fixation and depend upon the difference between the distances A and B in the figure.

6. Comprehension ratings. These results were obtained from the answers to three questions regarding the content of each paragraph.

7. Pulse and blood pressure were also recorded at regular intervals during each experiment.

Results

Both the control and experimental groups showed increases in the time in seconds required for reading six lines of print at 18,000 and 15,000 feet, respectively (10.5- and 11.5-percent O_2). The variability of the groups increased, though more markedly in the control group. These increases were highly significant.* The fast readers at sea level tended to be the fastest in reduced oxygen as evidenced by correlations† of over 0.92.

There was a significant increase for both groups in the average number of fixations per line in reduced oxygen corresponding to 18,000 feet for the control group and 15,000 feet for the experimental. The variability increased slightly for both groups. The patients in both

TABLE 3

MEANS, STANDARD DEVIATIONS, CORRELATIONS, AND SIGNIFICANCE OF OBSERVED DIFFERENCES FOR AIR, AND 11.5-PERCENT O_2

Experimental Group

	Control		11.5% O_2*		Correlation Control and 11.5% O_2	D/ΣD† (Significance of the Observed Difference) Control and 11.5% O_2
	Mean	S.D.	Mean	S.D.		
Time	14.47	1.64	16.21	1.85	.92±.03	8.83
Fixations	8.72	2.24	9.46	2.31	.89±.04	2.29
Regressions	1.31	0.91	1.74	0.57	.82±.07	2.59
Line Divergence	0.59	0.31	0.68	0.41	.55±.14	0.84
1st Fixation Divergence	0.46	0.19	0.44	0.20	.92±.03	1.04
Divergence All fixations	0.19	0.09	0.17	0.06	.41±.17	0.80

* Altitude range 14.0- to 10.5-percent, mean 11.5-percent O_2.
† 2.20 Significant (cf. Guilford).

* Not due to chance variations.

† Rank order correlation (cf. Guilford, J. P. Psychometric methods. New York, McGraw-Hill, 1936).

groups again maintained their ranks with correlations of over 0.90.

The control group showed a slight decrease in the average number of regressions in low O_2, but this change was not significant. The variability tended to remain constant. The experimental group showed a significant increase in the average number of regressions with a decrease in variability. There was a tendency for each individual to keep his relative position in the group (correlations of 0.95, 0.83, 0.82).

The various measures of binocular relations indicate that for the control and the experimental patients the optic axes tend to diverge* during fixations under all conditions. There is an approximation of a similar magnitude during the saccadic movement. These relations hold true even for patients with heterotropias who read with only one eye.

There is a tendency toward a decrease in the extent of divergent movements in reduced O_2 as compared to sea level conditions for both groups. This change is significant only for the control group at 10.5-percent O_2 (18,000 feet). It will be noted that the divergence in general is much larger for the first fixation than for the succeeding ones on the line.

The means for all data for the experimental group are higher (but not significantly) than those for the control group, indicating that as a group the experimental patients are slower readers, require more fixations and regressions, with larger adjustments during fixations. It was found that in the control group the better readers tended to make slightly larger adjustments (larger divergent movements during fixations and convergence during saccadic movements) but

TABLE 4

MEANS, STANDARD DEVIATIONS, CORRELATIONS, AND SIGNIFICANCE OF OBSERVED DIFFERENCES FOR AIR, 12.5-PERCENT O_2, AND 10.5-PERCENT O_2.

Control Group

	Control		12.5% O_2		10.5% O_2		Correlation		D/ΣD* (Significance of the Observed Difference)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Control and 12.5% O_2	Control and 10.5% O_2	Control and 12.5% O_2	Control and 10.5% O_2
Time	10.65	2.81	11.85	4.48	13.05	4.18	.95	.98	1.58	4.15
Fixations	7.81	1.95	7.99	2.23	8.45	2.07	.95	.98	0.61	4.00
Regressions	1.20	0.66	1.18	0.73	1.05	0.56	.95	.83	0.32	1.03
Line Divergence	0.50	0.23	0.50	0.27	0.48	0.25	.88	.71	0.15	0.11
1st Fixation Divergence	0.39	0.16	0.36	0.19	0.33	0.18	.83	.74	0.56	1.09
Divergence All fixations	0.15	0.07	0.13	0.06	0.12	0.05	.95	.88	0.73	3.02

* 2.36 Significant (cf. Guilford).

* Throughout this paper divergence is to mean a temporal movement of both optic axes and not a static condition. Convergence will signify a movement of both optic axes nasally and not a static condition.

since even greater adjustment was made by the experimental group, there may be an optimal range for normal eyes.

The comprehension ratings for the patients varied with the individual and with the altitude. At the higher altitude, comprehension ratings fell off quite markedly and may represent an impairment of successive perception or of memory for immediate recall.

level by the end of the hour in 12.5-percent O_2 (13,500 feet), while no such adjustment took place in 10.5-percent O_2 (18,000 feet). This procedure was not repeated on the experimental patients because of their physical condition.

There appeared to be little, if any, relationship for the group as a whole between the eye-movement records while reading and the eye examinations. For

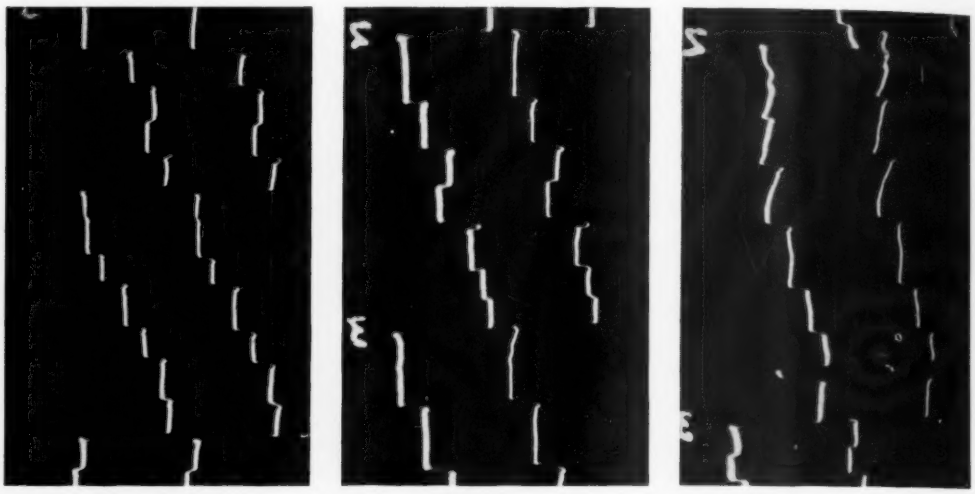

Fig. 3 (McFarland, Knehr, and Berens). Case 1. Eye-movement photographs while reading. Note the characteristic "hook" at the beginning of each fixation. In 10.5-percent O_2 (17,500 feet) the record shows an increase in time and number of fixations as well as marked unsteadiness.

The pulse and blood pressure records indicate that the changes were too slight to account for the alterations in ocular movements.

In our previous study[12] the control patients were studied at sea level and at two different altitudes (13,500 and 18,000 feet or 12.5-percent and 10.5-percent O_2) during an hour period. The eye movements while reading were photographed three different times during each experiment so that the degree of acclimatization that took place might be observed. There was a tendency for reading time and extent of binocular adjustment to return toward the normal response at sea

example, when the data for the heterophorias were arranged in rank order and correlated with the data on changes in vergence from the eye-movement photographs, there was no significant correlation. There were significant relationships, however, between certain of the individual photographic records and the eye examinations. It was necessary, therefore, to interpret some of the changes by direct reference to the eye-movement photographs. A number of these relationships are discussed separately below:

Case 1. A male, aged 24 years: The ocular photographs of this patient are quite characteristic, all of his records, including

the control, showing the slight "hook" at the beginning of most fixations. The record in 12.5-percent O_2 appears to be qualitatively similar to that of the control. In 10.5-percent O_2 the sliding fixations, the general unsteadiness, and the lengthening of time are markedly increased. The findings on the eye examination revealed low visual acuity and a relative central scotoma (5 degrees) for form in the left eye (table 1).

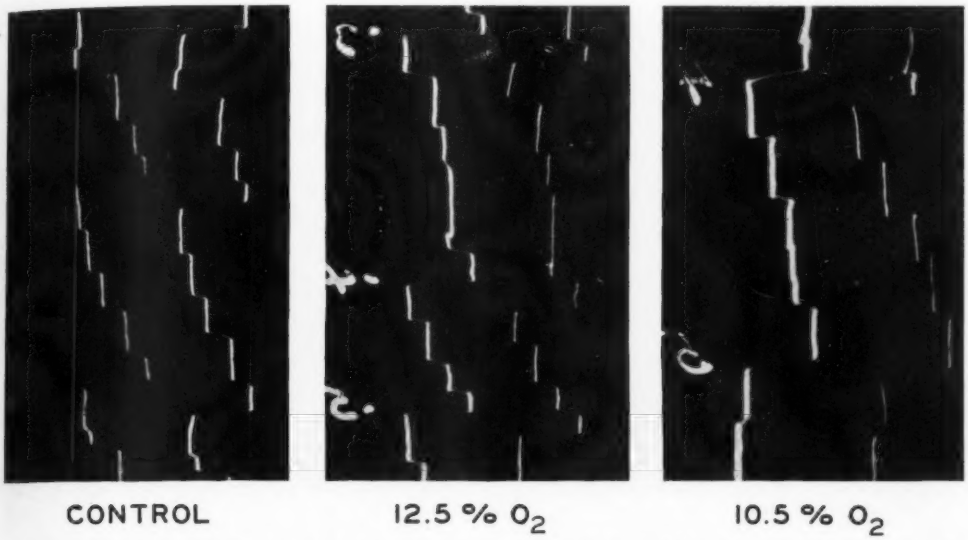

Fig. 4 (McFarland, Knehr, and Berens). Case 2. These records in 12.5 and 10.5 percent O_2 (13,500 feet and 17,500 feet) show marked irregularities. The left hyperphoria is manifested by an increase in the distance between the tracks. Record on left, control; middle, 12.5-percent O_2; right, 10.5-percent O_2.

Case 2. A male, aged 20 years: This patient was found to have left hyperphoria. His reading was rapid, with few fixations and good comprehension. The adjustments during fixations were made with either or both eyes. The record is not regular even in the control series. At the end of the fourth fixation in 12.5-percent O_2 the right eye is seen to make a movement not made by the left. In the 10.5-percent-O_2 record the left eye shows a deviated movement (fourth fixation in the complete line shown). In most of the photographs in 10.5-percent O_2 there is a gradual increase in the distance between the tracks. This increase in distance between the recordings for each eye indicates convergence; but since we know it was a vertical deviation, it represents an artifact, which has been discussed in a previous study.[12] This is due to the location and change in location of the points of incidence of the reflected light on the corneas during the photographing procedure. These points creep together on the cornea with vertical deviation or even upon reading successively lower lines of print. Comprehension was medium in 12.5-percent O_2 and poor in 10.5-percent O_2.

Case 3. A male, aged 12 years: Three years prior to the experiment, the patient had had a retroplacement (4 mm.) of both medial recti to correct an alternating esotropia. He was in very poor physical condition and quite "nervous." The nervousness increased markedly at 10,000 feet. It was thought inadvisable to test this patient under more extreme condi-

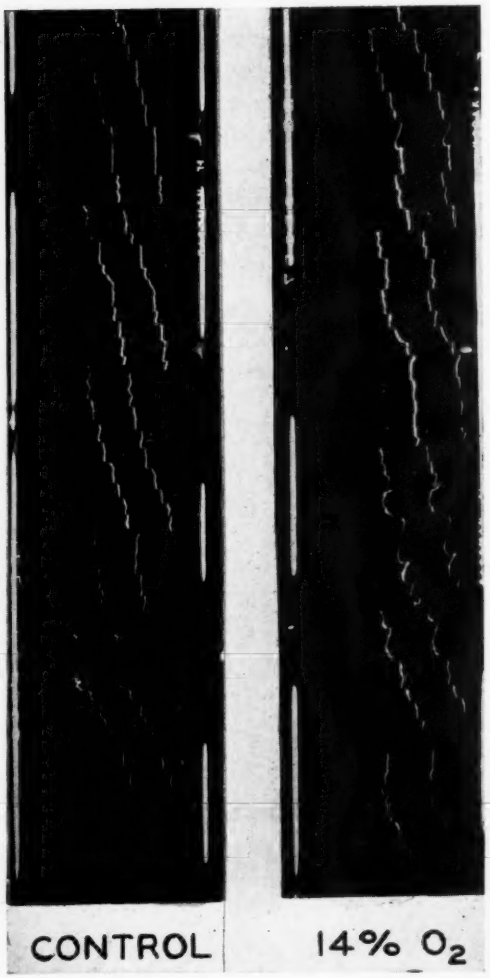

Fig. 5 (McFarland, Knehr, and Berens). Case 3. This record shows an increasing unsteadiness in 14-percent O_2 (10,000 feet).

tions of oxygen deprivation. Even with an exophoria of 10^{Δ} at 25 cm., the divergent movements during fixation were the smallest recorded on the first fixation, indicating that some factor besides muscle balance was operating. The record (at 10,000 feet, see figure 5) shows a marked accentuation of the sea-level findings.

Case 4. A female, aged 30 years: This patient was wearing prisms to correct an exophoria with left hyperphoria. Fusion was maintained most of the time with correcting lenses but without prisms the patient reported vertical diplopia. Reading was reported to be more difficult in low oxygen. Steadiness fixation was less precise at 12-percent O_2, as can be seen in the record. The steadiness fixation was photographed while the patient opened and closed her eyes, the initial fixation changing almost immediately to a condition of vertical diplopia as indicated by sudden widening between the tracks a few millimeters beyond where they appear.

Case 5. A female, aged 22 years: This patient showed a condition of alternating esotropia in the control record by the shift of the two tracks. Oddly enough, this shift did not occur in low oxygen. It is quite possible that one eye was used throughout the low O_2 condition for reading. The steadiness fixation may be seen to be less regular in diminished oxygen.

Case 6. A female, aged 28 years: This

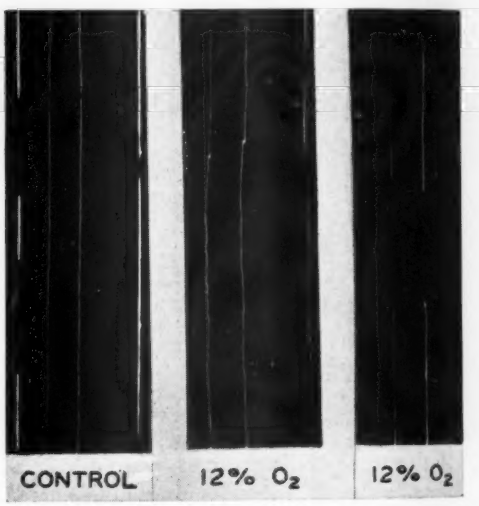

Fig. 6 (McFarland, Knehr, and Berens). Case 4. In these photographs of steadiness fixation there is increasing unsteadiness in 12-percent O_2. The record at the right shows the behavior of the eyes upon opening and closing them. Upon fixating the stimulus object fusion occurred followed by diplopia, as evidenced by a slight widening of the distance between the two tracks.

was a case of divergence excess which became accentuated at 11.25-percent O_2 (approximately 16,000 feet). The patient reported difficulty in maintaining fusion, and this was evidenced in the steadiness fixation by the approach of one eye track to the other, whence there was a shift back to fusion. Another interesting appearance is the nystagmoid movements at 16,000 feet.

Case 7. A female, aged 30 years: This patient was operated on in 1925 to correct esotropia and was also suffering from an endocrine disturbance. The muscle balance varied from examination to examination. At the time of testing she showed 11$^{\Delta}$ of esophoria. At sea-level conditions she was able to fuse most of the time in the steadiness fixation, with an increase in difficulty of fusion in low oxygen. As she began to read under control conditions, the esotropia developed almost immediately (as indicated by the larger distance between tracks on the photographic record), neglecting her left eye and reading with the right. She developed

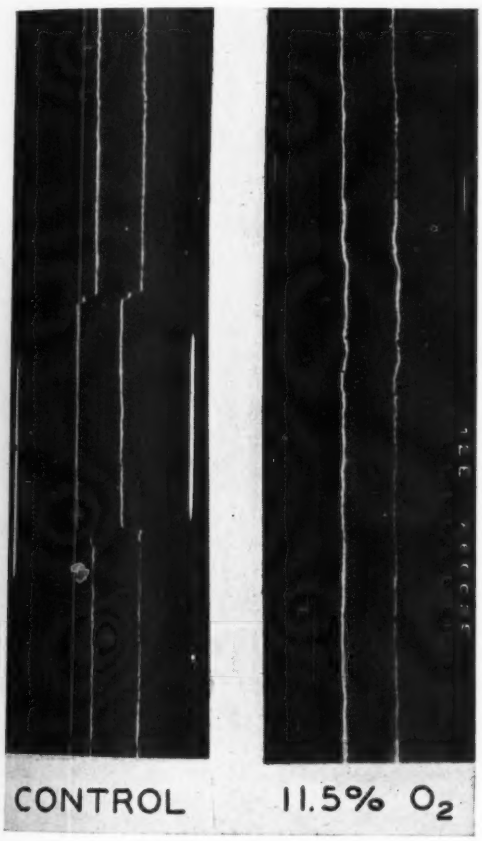

Fig. 7 (McFarland, Knehr, and Berens). Case 5. The alternating esotropia is manifested in the control record during fixation by the shifting of the eye records. In 11.5-percent O_2 (15,000 feet) there are circular movements as well as increased unsteadiness.

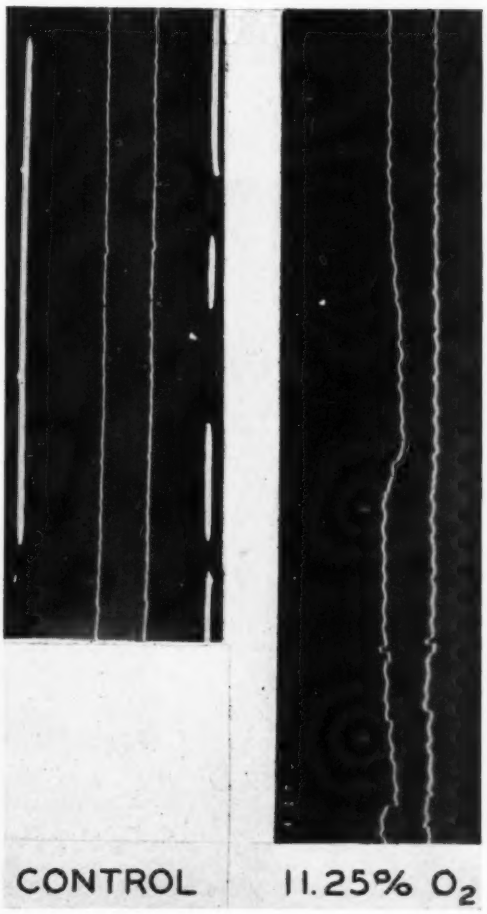

Fig. 8 (McFarland, Knehr, and Berens). Case 6. The divergence excess in this patient is clearly observable during steadiness fixation in 11.25-percent O_2 (16,000 feet). Note how the gradual divergence is followed by fusion. The nystagmoid movements are quite marked in anoxemia.

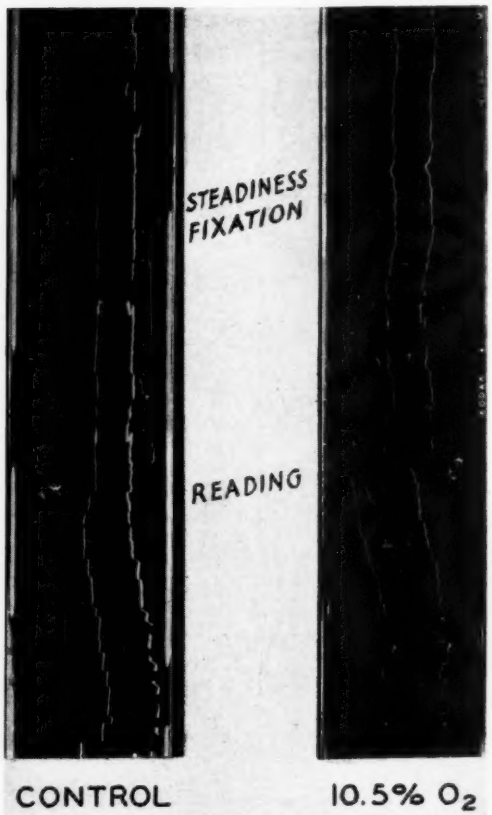

Fig. 9 (McFarland, Knehr, and Berens). Case 7. This record shows fusion during steadiness fixation. When the patient began to read, the eye tracks widened, manifesting the condition of esotropia. The change is more pronounced at 10.5-percent O_2 (17,500 feet).

esotropia almost immediately in 10.5-percent O_2 (17,500 feet) and to a greater degree than she did under sea-level conditions. This is hard to explain because the visual axes under low-oxygen tension usually tend toward divergence. In this particular case a possible explanation may be that the patient had abnormal retinal correspondence, fairly well fixed, and under the conditions of low-oxygen tension the stimulus to fusion in this area was lessened, with the resulting greater degree of esotropia.

Case 8. A male, aged 31 years: In the control test at sea level, horizontal optic nystagmus occurred at the rate of five per second. On the record, the amplitude of movement was 1 mm., corresponding to an angular excursion of the eye of 2 degrees of arc. Under artificially induced altitude of 18,000 feet (10-percent O_2), the nystagmus became less regular and the frequency was reduced to 3.4 per second, or approximately two thirds. The amplitude doubled and was equivalent to an angular deviation of more than 4 degrees and was less regular as compared to the sea-level record, with an increase of four times the variability.

A possible explanation for the decrease

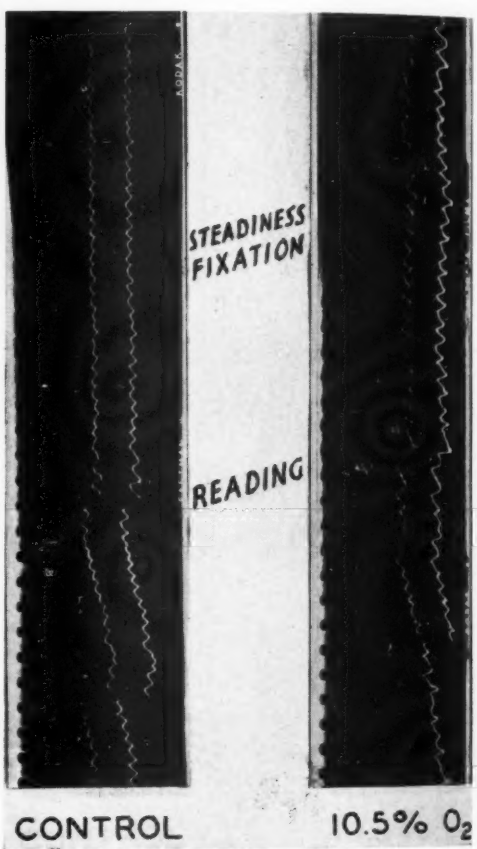

Fig. 10 (McFarland, Knehr, and Berens). Case 8. In this case of lateral optic nystagmus the reduced oxygen (10.5-percent O_2) produces an increase in amplitude of movement and a decrease in the rate per second.

in frequency and increase in the amplitude is that the attempt to converge is an important factor in reducing the amplitude in nystagmus movements, and in many patients nystagmus is completely abolished during convergence. From this experiment in reading, as well as from previous studies on the effects of altitude on ocular functions, it is indicated that, although convergence is primarily stimulated, secondarily there is a diminution in convergence power, shown by an increasingly remote near point of convergence and a lessening of prism convergence. The fact that the convergence stimulus weakens possibly accounts for the increase in the amplitude of the excursion, and this would tend to decrease the frequency of the nystagmus movements.

Discussion of results

The results of this study indicate that the effects of oxygen deprivation on eye movements while reading produces an increase in the time and the frequency of fixations and reduces the precision and adequacy of the ocular adjustment. The effects were similar for both the control and the experimental patients. These effects may be ascribed to the diminished amount of oxygen being delivered to the nervous tissues. The reactions studied probably involved the subcortical as well as the cortical areas of the brain because of the loss of motor control in the steadiness of fixating test objects.

The alterations observed in the ocular movements while reading in reduced oxygen can hardly be attributed to diminution in attention, nor can the variations be ascribed to alterations in pulse rate and blood pressure, since the changes were slight. Anoxemia produces vasodilation and an increased blood flow which, however, is not sufficient to counteract anoxemia. It seems more reasonable to attribute the changes to the diminished excitability of the nervous tissue. This is caused by the diminished arterial oxygen saturation and the consequent lack of oxygen being delivered to the nervous tissue.

The measure of the binocular relations during fixations indicates that there was a divergent movement of the optic axes during fixation and an approximation of the axes during the saccadic movement. It has been thought by some that such a measure might be related to the muscle balance. Since no statistical correlation between them has been found in this study, and further since the same phenomenon of divergence during fixation occurs not only in patients with visual acuity and heterophorias within the normal range but also in those with heterotropias who read with only one eye, it is suggested that there is little relationship between this measure and the heterophorias.

One possible explanation is that an increase in accommodative effort may result in an increase in whatever vergence may be actively present, with a resulting relaxation in vergence upon diminution of accommodative effort. This relaxation can occur while the eyes are marking time; that is, waiting for perception.

The larger means in the data for the experimental group as compared to the control group are probably related to the abnormalities. One factor giving rise to the increased time and greater number of fixations required by the experimental group is perhaps the poorer educational background of some of the patients, and also the presence of young patients in this group. This does not account for all of the differences, however, since similar differences occurred in the data on binocular relations.

The accentuation of defects was evi-

dently greater in the patients with motor anomalies than in the control patients, although even under normal conditions certain defects become manifested. For example, it is known from the reading record of the subject in case 7 that fusion occurred during steadiness fixation on a test object, but during reading there was suppression of one eye, and not always the same eye. This same phenomenon was markedly accentuated under oxygen deprivation. In such instances the reading record becomes of clinical significance.

In comparing the findings of this investigation with those of other experimenters, it is quite apparent that deterioration to the extent of the production of significant changes in several of the measures was manifested with milder degrees of anoxemia than previously reported; that is, under conditions of oxygen lack corresponding to those at 13,500 to 15,000 feet. In this study of eye movements, psychological factors such as variation in effort or knowledge of results would seem to be insignificant. The test has proved to be a sensitive one in detecting the early effects of oxygen deprivation.

Summary and conclusions

1. A significant increase was found in the reading time of control and experimental patients in oxygen concentrations corresponding to 15,000 to 18,000 feet. A similar increase was found in the number of fixations. A significant increase in regressions was made by the experimental group and a slight decrease (not significant) by the control group.

2. The visual axes of patients with normal refraction and muscle balance and those with diminished acuity, muscle imbalance, and heterotropias showed (1) divergent movements during reading fixations and (2) convergence during the saccadic movements in normal and reduced oxygen concentrations. Since this occurs even in esotropia it may be related to variations in vergence caused by changes in accommodative effort.

3. A decrease in the extent of divergent movements occurred in reduced oxygen for both groups, and was significant for the controls at 18,000 feet.

4. The data showed no statistical relationship to the eye examination for the two groups as a whole. When the photographic records were analyzed individually, however, significant alterations were observed which could be definitely related to the findings from the eye examinations.

5. The general qualitative characteristics of the ocular movements for both groups showed a diminution of precision in oxygen want, with the appearance of nystagmoid movements, general unsteadiness, and accentuation of abnormalities.

6. A decrease in comprehension of the reading material was observed for all of the patients in reduced oxygen. This may represent an impairment of perception or of memory for immediate recall.

7. The data from 10 patients indicated a tendency toward acclimatization by the end of one hour at 13,000 feet (12.5-percent O_2). No such adjustment was detectable at 18,000 feet (10.5-percent O_2).

8. Photographic records of ocular movements obtained during reading appear to be of some value in the diagnosis of clinical anomalies. This method objectively records the movements of the eyes in a normal situation. Under conditions of anoxemia the latent defects frequently become apparent and those present become accentuated. Therefore, this procedure may be of clinical significance.

9. The eye-movement photographs showed that reading time per line and

adjustments during fixations were sensitive measures of the early effects of anoxemia.

10. The decrease in efficiency of ocular movements under anoxemia may be attributed to the diminished amount of oxygen being delivered to the nervous tissue, subcortical as well as cortical.

Bibliography

[1] Anonymous. Rhythm Reading. The ophthalmograph. Chicago, American Optical Co., 1935, pp. 35.

[2] Barach, A. L. Oxygen chamber simplified in design and operation. Jour. Amer. Med. Assoc., 1931, v. 97, pp. 390-391.

[3] Berens, C. Present ophthalmologic standards for commercial aviation in the United States. Jour. Aviation Med., 1932, v. 3, no. 2, pp. 55-101.

[4] ——— (editor). The eye and its diseases. Philadelphia, Saunders, 1936, pp. 1254.

[5] Dodge, R., and Benedict, F. G. Psychological effects of alcohol. Carnegie Inst., 1915, Pub. No. 232, pp. 281.

[6] Gellhorn, E., and Spiesman, I. G. The influence of hyperpnea and of variations of O_2 and CO_2 tension in the inspired air upon afterimages. Amer. Jour. Physiol., 1935, v. 112, p. 620; upon nystagmus, *Ibid.*, 1935, v. 112, 662; upon visual intensity discrimination, *Ibid.*, 1936, v. 115, p. 679.

[7] Goldmann, H., and Schubert, G. Untersuchungen über das Gesichtsfeld bei herabgesetztem Sauerstoffdruck der Atmungsluft. Arch. f. Augenh., 1933, v. 107, p. 216.

[8] Javal, E. Essai sur la physiologie de la lecture. Ann. d'ocul. 1878, v. 79, pp. 97-117, 240-274; 1878, v. 80, pp. 135-147; 1879, v. 81, pp. 61-73, 157-162; 1879, v. 82, pp. 72-81, 159-170.

[9] McFarland, R. A. The psychological effects of oxygen deprivation (anoxemia) on human behavior, Arch. of Psychol., 1932, no. 145, p. 135.

[10] ———. Psycho-physiological studies at high altitudes in the Andes. Part I. The effects of rapid ascents by aeroplane and train. Jour. Comp. Psych., 1937, v. 23, pp. 191-225; Part II. Sensory and motor responses during acclimatization. Jour. Comp. Psychol., 1937, v. 23, pp. 227-258; Part III. Mental and psychosomatic responses during acclimatization. *Ibid.*, 1937, v. 24, pp. 147-188; Part IV. Sensory and circulatory responses of the Andean residents at 17,500 ft. *Ibid.*, 1937, v. 24, pp. 189-220.

[11] ———, and Barach, A. L. The relationship between alcoholic intoxication and anoxemia. Amer. Jour. Med. Sci., 1936, v. 192, p. 186. Cf. also McFarland, R. A., and Forbes, W. H. The metabolism of alcohol in man at high altitudes. Human Biol., 1936, v. 8, pp. 387-398.

[12] McFarland, R. A., Knehr, C. A., and Berens, C. The effects of oxygen deprivation on eye movements in reading. Jour. Exper. Psychol., 1937, v. 21, pp. 1-25.

[13] Taylor, E. A. Controlled reading. Chicago, Univ. Chicago Press, 1937, pp. 345.

[14] Scofield, C. F. The effects of mild doses of alcohol and caffeine on optic nystagmus. Psychol. Monog., 1936, v. 47, no. 2, pp. 217-241.

[15] Tinker, M. A. Reliability and validity of eye movement measures of reading. Jour. Exper. Psychol., 1936, v. 19, pp. 732-746.

[16] ———. Eye movements in reading. Jour. Educ. Res., 1936, v. 30, no. 4, pp. 1-37.

[17] Vernon, M. D. The experimental study of reading. Cambridge, Cambridge Univ. Press, 1931, pp. xv-190.

[18] Wilmer, W. H., and Berens, C. Medical studies in aviation. V. The effect of altitude on ocular functions. Jour. Amer. Med. Assoc., 1918, v. 71, no. 17, pp. 1394-1398.

Discussion

Dr. Lancaster: The essayist says that the defects are due to a reduction in the amount of oxygen delivered to the central nervous system. In another place he speaks of the muscles as being weaker. Which does he think is the real effect?

Dr. Berens: In discussing this point with Dr. McFarland, we came to the conclusion that the nervous tissue is much more likely to be affected than the muscular. Under acute anoxemia all tissues of the organism would be affected. There

seems, however, to be general agreement among physiologists that the nervous tissue is especially sensitive to oxygen deprivation.

DR. VERHOEFF: Did you measure the time of the saccadic movements?

MR. KNEHR: It has been measured, but cannot properly be measured on this machine. It is measured by having a rapidly spinning disc produce on the film a dotted time line, each dot representing 1/100 of a second. Counting the number of these in each saccadic movement gives the time. The saccadic movement takes approximately 7 percent of the total time of the reading record. It is a very rapid movement, and although the film is moving, photographs as a horizontal line, as you can see.

DR. VERHOEFF: Have you measured the saccadic movements by other methods than your own?

MR. KNEHR: No. However, it has been measured by more accurate instruments by the scientists who developed this particular technique. They found that the length of such a movement is several hundredths of a second.

DR. E. V. L. BROWN: I want to preface my question with an illustration. At the University of Chicago High School, an investigation was made on a group of 20 students in an attempt to relate their emotional behavior to reading ability. A 12-year-old-girl was brought in with the poorest eye-movement records that Professor Gray and his staff had seen over a period of 10 years. It turned out that she was five years ahead of anybody in her class in reading ability, and the question arose as to whether or not she was reading with one eye most of the time. Have you any data on that?

MR. KNEHR: That is a question I cannot answer, without seeing the records, but I think you will find it is true that some of our good readers have what might be called poor reading records, as is shown in the literature.

DR. BROWN: You mean poor from the photographic standpoint.

MR. KNEHR: Yes. Dr. McFarland's own reading record is quite irregular under anoxemia. If you were to send such a record to Dr. Gray or to Dr. Dearborn, they might say that this is the record of a poor reader. It is important to keep in mind the fact that the eye-movement photograph varies with the type of reading material; that is, whether one is accustomed to difficult scientific literature or light reading, as in the case of a novel, and the conditions under which the reading is done.

It is not at all certain that one can prove that a particular type of reading record necessarily goes with a particular type of reading ability. The correlation, of course, has been made with various types of educational tests, and it has been found that ordinarily the most rapid reader on this machine, and the one who reads with the fewest fixations, and so on, is the best reader; but the question of small movements, such as we have been trying to measure, has not been studied from the standpoint of correlating them with the reading ability as measured by one of the standard reading tests.

DR. BROWN: My question was whether or not the one eye was doing a lot of the reading.

MR. KNEHR: I cannot answer that. The matter of the master eye has been receiving attention. Professor Dearborn, who heads the Psycho-educational Clinic at Harvard, believes that left dominance, or mixed dominance (for example the left hand–right eye) has some relationship to reading disability. But the matter of whether the person is reading with one eye or not probably makes little difference.

DR. VERHOEFF: Isn't the point whether

we have a fixation or not while reading? I don't know exactly what Dr. Brown meant, but I presume he meant, is the patient fixing with one eye all the time?

DR. BROWN: That is what the photographs were showing, only one eye at a time.

MR. KNEHR: Were those the earlier photographs, the photographs on only one eye?

DR. BROWN: No, the two together. But they never seemed to fix alike. The two eyes were not working together at all.

MR. KNEHR: That may possibly be due to an artifact in this method of photography. Sometimes one gets a head movement to the side. There should be a white spot here (pointing to forehead) which will record the movements of the head so that one knows whether the record is a result of head or eye movements.

We are certain these are eye movements, but under some conditions it is difficult to tell without proper controls. In case 2 (right hyperphoria), the patient's record indicates that he was a poor reader but in fact he was a very rapid reader and comprehended well.

LIGHTING STANDARDS

WALTER B. LANCASTER, M.D.
Boston

The members of the American Committee on Optics and Visual Physiology are of the opinion that ophthalmologists should know more about illumination. We advise them to buy or borrow a light meter and make scores of measurements of the lighting in foot-candles in many places—in their offices, homes, stores, work rooms, schools, and so forth. It is well to make a guess before measuring so as to cultivate an ability to estimate the brightness of the lighting under different conditions.

It will be found: (1) That different individuals differ widely in what they deem satisfactory lighting under various conditions. (2) That satisfactory lighting depends on other factors besides merely the brightness of the light falling on the work. Hence the rather wide differences of opinion as to what constitutes good lighting. It is the purpose of this essay not merely to give the opinion of the writer or of the members of the Committee (though all the members endorse what is here written) but to set forth the grounds on which a valid opinion must be based and give references to the experiments and investigations that are fundamental to a sound judgment about lighting in any given case.

CRITERIA

In order to pass judgment on lighting, one must have some criteria of what constitutes good or bad lighting. Various criteria have been proposed. Among the most useful are visual acuity, visual efficiency, visual speed, visual comfort, and visual health.

Visual acuity. Since the object of lighting is to facilitate seeing, it is natural to judge lighting by its effect on visual acuity. The lighting must be sufficient to see by. Is it fair to say that the lighting should give the maximum possible visual acuity? No, because most visual tasks, like reading ordinary print, can be done easily with less than the maximum visual acuity. When the task is more difficult provision should be made for better seeing.

Many investigations have been made, and it is well established that tested with

Snellen letters, and starting with illumination below .01 ft-candles and gradually increasing up to say 10,000 ft-candles the curve of visual acuity has the well-known form. There is a gradual rise at the beginning when the vision is dependent on the rods (scotopic vision). Then there is a very rapid rise starting at about 0.1 ft-candles when the cones come into play (photopic vision). The rate of increase slows down after, say 50 ft-candles as the curve distinctly bends over and approaches the horizontal. However, there is a slight increase for a long time until with *very* intense illumination the acuity falls off. Koenig's is the classic research on this phase of the subject. R. J. Lythgoe (Medical Research Council, Reports of the Committee upon the Physiology of Vision: X. "The measurement of visual acuity," H. M. Stationery Office, London) has clarified the subject by showing the importance of some neglected factors. Hecht's is another accessible contribution to the subject (Arch. of Ophth., 1928, v. 57, p. 564).

The striking thing about the relation of visual acuity to illumination *is the wide range over which acuity is good,* say from 5 ft-candles to 10,000 ft-candles. Even below and above those figures acuity is fair. Certainly with as little as 3 to 5 ft-candles it is possible to see fine detail fairly well if the contrast is high.

This wide range over which acuity is good greatly simplifies the decision of how much light is advisable. For indoor lighting, we do not have to consider the possibility of too much light, because the safe maximum is so far above the minimum. For example, if one were asked about the proper amount of light for a library, he might reflect that in using a library not all the work done consists of reading good black print on white paper. Old manuscripts may have to be deciphered, maps studied, pictures of various kinds examined, some with little contrast in various parts of the picture. Some of this work might require 100 ft-candles, but most of the fine work could be done with 20 ft-candles, so he decides to provide 20 ft-candles in general and means for additional local lighting up to 100 ft-candles. Knowing that the eyes tolerate, and perform efficiently with, light as strong as thousands of foot-candles, he is sure that he is well below any dangerous maximum and has on the other hand avoided a too low minimum. This ignores the question of cost which has been, and will continue to be, a powerful factor in keeping the recommended standard low. As more and cheaper light has become available, the best authorities have steadily raised their minimum requirements.

These acuity tests are made with the usual Snellen or with the international Landolt test charts. But eyes are used for many purposes that differ widely from the reading of standard charts. Thus, if instead of black letters on white background, gray letters on a lighter gray background are used, very different results are obtained. Instead of needing 10 ft-candles to recognize characters of 6/5 size 100 ft-candles may be needed. For example, a black object on a background reflecting 80 percent and illuminated by 10 ft-candles would give the same result as a black object on a background reflecting 8 percent with illumination of 100 ft-candles.*

Hence, attention must be given to two other factors: (a) *Contrast.* An object such as a letter is seen because of the contrast between it and its background. The contrast between objects and their sur-

* Luckiesh and Moss: Seeing, p. 38, "It is obvious that a surface reflecting 80 percent of the light received has the same brightness under 10 ft-candles as a surface reflecting 8 percent of the incident light when it is illuminated to 100 ft-candles).

roundings may be one of color difference or of brightness difference or both. (b) *Brightness.* The brightness of an object depends not only on the amount of light falling on it but also on its power to reflect the light. It would be more accurate, therefore, to specify the brightness of the objects in the number of millilamberts that must be provided by good illumination, than to specify the intensity in lux or in foot-candles of the light falling on the work; however, the latter is much more convenient and less technical.

1 ft-candle = 1 lumen incident per sq. ft.

If reflection were perfect (100 percent coefficient of reflection) 1 lumen *incident* per sq. ft. would result in 1 lumen *emitted* per sq. ft.

1 lumen emitted per sq. ft. = (approx.) 1 millilambert, the unit of brightness.

1 meter candle = about .09 ft-candles = 1 lux

We must never lose sight of the importance of the brightness of the object and background due to their coefficients of reflection, and of the importance of the factor of contrast.

Contrast is measured in percentage. To find the contrast in a given case, find the difference in brightness between the object and its background. The background may reflect 80 percent of the light falling on it. The black letters reflect about 8 percent of the light falling on them. The difference is 72. To find the percentage contrast, this figure 72 must be divided by the figure representing the background, or 80. This gives 72/80 = .90 = 90 percent as the percentage contrast. Suppose the letters were gray, reflecting 40 percent of the light falling on them and the background lighter gray, reflecting 50 percent. The difference is 10. When this is divided by 50, representing the background, we have 10/50 = 20-percent contrast. The percentage contrast would be the same whether the illumination were 5 ft-candles or 100.

Experiments show that with high contrast—very dark objects on very white background—less illumination is needed. Suppose 10 ft-candles was needed in the first case for 6/5 vision, then 45 ft-candles would be needed in the second case to make up for the reduced contrast. If the contrast in another case were only 5 percent, then 180 ft-candles would be needed to recognize characters of 6/5 size. Instead of increasing the illumination the size of the test object (visual angle) could be increased; then in the last case with 5-percent contrast the size would need to be 18 times as large to make the characters as easily seen.

Perhaps a practical but sound method of arriving at the illumination needed in a given case is to estimate what would be needed if the task to be done were reading black print on white paper of average size, taken as a standard.

8-point type, average blackness = 8 percent reflection coefficient.

Paper, average whiteness = 80 percent reflection coefficient = 90 percent contrast.

Then find out how the real task varies from this standard:

If the visual angle is smaller (objects to be discriminated more minute than 8-pt. type).

If the contrast is less.

If greater speed is needed.

If the worker has refractive errors, and allied troubles.

If he has poor visual acuity.

If the duration of the task will be prolonged.

Under any of these conditions, more light will be needed.

From these considerations, it is evident that the illumination must be adapted to the work to be done and so will depend on the size of the objects dealt with, their

coefficient of reflection, the contrast between the object and the background, and the speed involved. The brightness required will vary from less than 5 ft-candles for passage ways, cellars, backyards, and the like, to around 10 ft-candles for reading, 50 to 100 ft-candles for operating, and even higher for special work with low contrast, such as sewing on black with black thread.

Visual Efficiency. It is not enough to have such illumination that the eyes can *see* the work (visual acuity); good illumination should be such that a maximum output, with a minimum of errors, at a minimum cost, is made possible. This is a criterion well adapted to statistical study in industrial plants of various kinds, schools, and the like. Many investigations have been made, and it has been shown that from the point of view of efficiency good lighting increases output, is therefore a paying proposition. Money spent on improved illumination results in greater profit in addition to the benefit to the worker's visual comfort and visual health. (References in Luckiesh and Moss: "Seeing," chap. 19.)

The amount and character of the illumination should depend, of course, on the work. In a general way we may say that it should be bright enough for good visual acuity, and of a character conducive to eye comfort and health. Since among the workers there will probably be some with eye defects, the standard should be higher than that required for healthy, young, normal eyes. Also, the law of diminishing returns applies, so that it may not pay to install anything better than a moderately good illumination. For instance, the level of illumination satisfactory in passage ways, storage rooms, cellars, and so forth, may be 3 to 5 ft.-candles. No doubt 20 to 30 ft.-candles would be better but not enough better to warrant the expense.

Speed of Vision is sometimes a valuable criterion. The eyes are constantly shifting their fixation but pausing long enough on a single point "to see" it. The time required for fixation by the eyes of a given object long enough to see it, that is, to recognize it with an accuracy approaching 100 percent,* is what is measured in testing the speed of vision. The time saved by improved illumination in a given visual act may be only a few hundredths of a second. The saving of a few hundredths of a second repeated several times a second, as in reading, or inspecting, or other visual tasks, amounts to a great deal in the course of a day's work. It also contributes very greatly to accuracy and efficiency. For example, a defect in a piece of metal that is being inspected may be absolutely invisible if .07 second is allowed at a low illumination. It becomes visible if the time is increased or if the lighting is increased. An example from Lythgoe: A broken circle with the gap 0.75 mm. was illuminated by 3.2 ft-candles. The subject being tested gave 9 out of 16 correct answers. For the subject to give 14 out of 16 correct answers either the size of the test object had to be increased 17 percent or the illumination raised 335 percent to 10.72 ft-candles.

So far, we have considered only the brightness or intensity of illumination and the data do not require special medical knowledge. In fact most of the studies in this field have been made by Ph.D.'s rather than by M.D.'s. There are other very important considerations to be included in judging a given problem of illumination. These criteria are visual comfort and visual health.

Comfort requires adequate brightness for good acuity, but it also requires that the quality and distribution of the light shall be suitable.

(a) Quality. If by quality we mean wave length, experience shows that ordi-

* Lythgoe used a standard of 55 percent accuracy, 4½ times out of 8.

nary daylight is good and that artificial light may be, like daylight, of mixed wave lengths covering the whole spectrum, or it may be, like incandescent lamps and many other common sources, much stronger in the yellow part of the spectrum and weak in the blue. Thus the ordinary Mazda is more comfortable for ordinary purposes than the so-called "daylight" bluish bulbs. To some this seems strange. They think that since the eye was evolved under daylight environment, daylight must be the best. They overlook the selective sensitivity of the retina to different wave lengths. It is most sensitive to yellow with the sensitivity falling off toward the red and toward the blue. Hence it is not surprising that the eye finds yellowish light most agreeable. (Ferree and Rand have shown this: Trans. Illum. Eng. Soc., Feb., 1918). For color matching the daylight lamps are necessary.*

(b) Distribution is very important. It emphasizes and explains why the whole story is not told when the brightness in foot-candles has been satisfactorily determined. Distribution deals with such considerations as glare, excessive contrast, shadows, and direct, indirect, and semi-indirect lighting as well as flood lighting. It takes into account the luminaires, their location and number; their design, including various ways of shading, diffusing, combining, and concentrating the light. To consider here all these in detail is out of the question but certain well-established principles should be emphasized.

Glare is very objectionable and not tolerated in good lighting practice. Glare out of doors is due to great excess of light, as sun on snow, or on water, or on sand, or on a light pavement, or from headlights. Glare indoors is seldom due to too much light. It is almost always due to poor distribution; such as bare, exposed bulbs, even if frosted, so located as to be within the range of vision of the worker. In general the eyes prefer diffused light free from strong contrasts and harsh shadows. Concentrated sources of high brilliancy, even if not in the range of vision, are disagreeable. They favor glare from specular reflection. Specular reflection is reflection like a mirror, where the angle of reflection equals the angle of incidence. The other kind of reflection is diffuse reflection. Paper is apt to be smooth and shiny enough to have considerable specular reflecting power. If the light falling upon it is from a concentrated source, a specular glare results. But, even if the light and paper are so placed that the reflection is thrown in a direction which does not meet the eye, still the nonspecular part of the reflection is trying to sensitive eyes. Such eyes require well-diffused light from a large source.

This explains the discomfort resulting from direct lighting. If the source in a direct-lighting arrangement is a large area, such as a large window, there is no such difficulty as in direct lighting from small concentrated sources. The advantage of indirect lighting is that the light from the primary source is thrown on a large light-colored surface which becomes the secondary source. It may then be compared to light from the sky. It is not unindirectional, but is widely diffused, casting almost no shadow. The Lancaster pencil-shadow test for this feature is, as Lenz says in volume VII of the Kurzes Handbuch der Ophthalmologie, "simple and effective." It consists in holding a pencil parallel to a sheet of paper and about three inches from it. The paper is held so that the light falls perpendicularly upon it. If the light is diffuse, the shadow is very blurred. If the shadow is fairly sharp and clear-cut, the light is not diffuse but concentrated and not agreeable for reading.

* Ferree and Rand later modified their conclusions on the basis of a different source of daylight. See Arch. of Ophth., Lighting and hygiene of the eye, July, 1929.

The researches of Ferree and Rand on indirect lighting showed (what is not generally known) that, when the light is reflected by the luminaire so that a comparatively small area of the ceiling is intensely lighted and the greater part of the ceiling and upper part of the walls of the room are not brightly lighted, this kind of indirect lighting gives results in visual efficiency and visual comfort not much better than direct lighting. In other words, there is good indirect lighting in which the whole ceiling and the walls down to the top of the doors is the secondary source of light and there is bad indirect lighting in which a small area of the ceiling is the secondary source and is very much brighter than the rest of the ceiling and walls. Probably the commonest fault with indirect-lighting installations is too little light.

Visual Health as a criterion of good lighting is of paramount concern to us as physicians. Poor lighting makes seeing more difficult and so causes eyestrain. Most of the symptoms caused by poor illumination belong in this category—headaches, eye aches, fatigue (ocular and general), blurred vision, hyperemia resulting in conjunctival irritation, blepharitis, and photophobia. Poor lighting brings out and exaggerates existing eye defects (hyperopia, astigmatism, heterophoria).

Whether poor lighting can be blamed for such organic diseases as retinitis, cataract, and glaucoma is extremely improbable, That it can contribute toward these and other ocular diseases by reducing resistance, increasing vulnerability, is certain; but by far the chief role of poor lighting in affecting the health of the eyes is in the sphere of "eye strain."*

The kind of illumination calculated to avoid damage to the health of the eyes is precisely that which is best for comfort and good for visual acuity, efficiency, and speed.

A few rules based on wide experience may be given: The difference in brightness between a luminaire and its background should not exceed one to 20 if so placed as to be visible. A luminaire of high brightness should be at least 20 degrees above the level of the worker's eye, for bright lights falling even on the peripheral retina are conducive to discomfort. Light should be diffused. It may be obtained by direct lighting, if the source is a large area as a large window or skylight, or, in a sufficiently high room, from a very large number of separate direct sources; for example, in an auditorium several hundred lights in a row extending all the way around the edge of the ceiling, too high to be seen without looking up; that is, not in the field of vision when looking horizontally. If the source is a concentrated, very intense one, the light should be thrown on the ceiling and walls, which thus become the secondary source, providing indirect lighting. The two may be combined, semi-indirect, but in that case the brightness of the direct element (for example, the translucent reflector) should not be greater than two candles per square inch and should not be more than 20 times as bright as its background. For such work as reading when the contrast is good (black print on white paper) at least 10 ft-candles is to be recommended. For work with poor contrast, such as sewing on dark goods, more light is needed and can be well supplied by a local source near the work, throwing the light on the work, but shaded from the eye, and located so as to avoid disagreeable reflections.

To get a general illumination of a room of 20 ft-candles would require about three watts per square foot of floor space, pro-

---

* Lancaster. Eye strain and faulty illumination. Ann. Ophth., April, 1914.

———. Injurious effects of light on the eyes. New York Med. Jour., 1914, Aug. 29.

vided the walls and ceilings were light. Satisfactory lighting can be obtained with 1½ watts per square foot, but it is not so good as three watts, properly distributed to give well diffused, soft, agreeable, glareless light.

It may be asked how these rules or claims are established; on what do they rest? They are based on the results of much research by such workers as Cobb, Ferree and Rand, Luckiesh, Lythgoe, and many others. The data accumulated cover the visual acuity, efficiency, speed factors, and also the visual-comfort and visual-health factors. The last two are difficult to reduce to measurements but convincing results have been obtained; for example, by Ferree and Rand, and confirmed by others. We may illustrate by a few examples.

Practical application

If a *schoolroom* were never to be used for anything more difficult than reading good print, fairly good results could be obtained with 5 ft-candles. The reading of pencil marks on paper, still more of slate-pencil marks on slate and of chalk marks on blackboards requires considerably more light. So do sewing and drawing, looking up words in dictionaries, studying maps, and pictures. Moreover, in an average class of pupils there will be a not insignificant percentage who have visual defects (astigmatism, hypermetropia, heterophoria, corneal opacities, and so forth). These require more light, especially if they do not have properly fitted glasses. Bearing all these considerations in mind and aiming not merely to make the work visible, but so easily visible as to favor speed, save time, secure accuracy, and avoid unnecessary fatigue (all highly desirable for students and teachers), a minimum of 15 to 20 ft-candles is advised by practically all up-to-date authorities. For blackboards, charts, and so forth, a higher local illumination, say 30 to 50 ft-candles, is desirable. The latter might be accomplished economically by supplementary illumination similar to that used in art galleries.

This must be accomplished by good diffuse lighting free from glare, harsh contrasts, and shadows.

When fine drawing, fine sewing, and the like are to be done, the lighting should be more than the stated minimum.

For passage ways, halls, toilets, closets, 5 ft-candles is sufficient. Less than that amount suffices for seeing your way around, but favors the overlooking of dirt, and favors accidents. Much can be saved in electricity by having well-painted or whitewashed ceilings and upper walls and clean luminaires.

For *gymnasiums*, the light required depends on the work being done. Marching and the like require less than basketball, or other games where quick seeing is important. Bare, exposed lights must not be in the line of vision.

The lighting of our *waiting rooms* and *examining rooms*. Glare is very objectionable in any doctor's waiting room—above all in an ophthalmologist's waiting room. Dim artistic effects designed to afford an escape from bright lights are a failure. The majority of our patients are well enough to read and want a good reading light while waiting. This is not supplied by a so-called "reading lamp" unless the general illumination of the room is taken care of by suitable indirect or semi-indirect luminaires.

The lighting of *test* charts should be of the flood-lighting type—lighting the whole end of the room with the wall only slightly darker than the charts; for instance, 60 percent reflection coefficient for the walls and 80 percent for the charts. The brightness should be that produced by at least 25 ft-candles but not over 50 ft-candles. Lythgoe (loc. cit.) points out

the importance of "bright surrounds," that is, surrounding or peripheral field, as had already been emphasized by Cobb. (See Lythgoe, The measurement of visual acuity, pp. 22 and 44.) We have to do with maximum contrast of black on white. The lighting should be such as to produce a pupil of normal, ordinary working size. It is desirable to have a dim light available of 3 to 5 ft-candles, and perhaps gray letters on gray background, for testing hemeralopia.

For lighting the *perimeter* Ferree and Rand adopted 7 ft-candles. In many cases more light is desirable. In taking color fields, the size depends, to a marked degree, on the brightness of the stimulus. The important thing about lighting for perimetry is to be able to compare tests on different days. To do this with accuracy requires that the illumination shall not vary much. When one man wishes to compare results with another, allowance must be made for the lighting used. The fields vary with the size and brightness of the stimulus. Just as the size of the test object needs to be noted, so some account should be taken of the brightness.

The pendulum has been swinging toward higher and higher standards of brightness for nearly all purposes. It seems to me that it is swinging a little too far. It is true that daylight out of doors is often of a brightness of many thousand foot-candles; hence the eyes can stand extreme illumination. The point is that the eyes are so efficient that they achieve good results with much less. Moreover, it is to be remembered that intense light breaks down the visual purple and other visual chemicals very rapidly. To recommend a light which makes unnecessary demands on the retinal metabolism is of doubtful wisdom. Hence, I do not advise 50 to 100 ft-candles for artificial lighting of rooms for ordinary work.

What about codes? These are useful attempts to reduce to more or less arbitrary figures the current opinion of experts. As Luckiesh and Moss point out, ". . . codes imply a degree of definiteness and precision which would be extremely difficult, if not actually impossible to substantiate, by actual test."

A historical survey of codes is enlightening. The standards 15 years ago and five years ago compared with present standards show a strong tendency to raise the minima, for example:

	Boston Schools			I.E.S. Codes
Classes	*1902*	*1922*	*1932*	*1936*
(1) Office and classrooms	3	3- 6	8-12	15 "better more"
(2) Sewing, drafting		8-12	10-15	25 "better more"

and in 1932 the minimum for "regulatory authorities" was five and eight, respectively, in the classes (1) and (2).

In order to aid those who depend on the definite figures of codes, we add the following recommendations:

Standards recommended for various occupations:

Reading—10-20 ft-candles.

Sewing—10-200 ft-candles depending on color, contrast, fineness of work, and so forth.

Draughting—20-50 ft-candles.

Auditoriums—5-10 ft-candles.

Locker rooms, toilets—5-10 ft-candles.

Stairs and corridors—5-10 ft-candles.

Walls and ceilings—Ceilings white, or almost white, coefficient of reflection 75 or over 60 percent, not shiny. Lower part neutral 40-50 percent.

Brightness of luminaires—Not over 2 ft-candles per square inch.

In planning illumination, it should be borne in mind that an installation does not perform 100 percent at all times because there may be, at times, a slight reduction in voltage; dusty, dirty luminaires; old bulbs nearly burnt out; walls and ceiling that become dingy and reflect less light. Also, the character of the

work may not be identical; for example, finer print, or sewing on more difficult material. Some users may have defective eyes. Older people need more light. These are among the factors which make it unwise to advocate a minimum so low as to make the work barely visible with no margin.

Authorities

Visual-acuity criterion: The classical research, but not the earliest, on visual acuity as influenced by illumination, was by Koenig. His results have been confirmed by many. An accessible reference is Hecht's publication in the Archives of Ophthalmology, 1928, page 564. This contains references to other important researches and also shows how the results are compatible with the "all-or-none" theory. Another accessible reference is Duke-Elder's textbook of ophthalmology, chapters 22-23; also Lythgoe's "The measurement of visual acuity," a report of the Committee upon the Physiology of Vision, British Medical Research Council, 1932. This is sound and free from prejudice. It has a good bibliography.

Visual-efficiency and visual-speed criteria: The data for these are presented by Luckiesh and Moss in "Seeing," published by Williams and Wilkins, 1931, with many references.

The work of Dr. P. W. Cobb is particularly sound and scientific.

In reading Luckiesh, it is necessary to discriminate between his statements of the results of well-made experiments and his inferences and conjectures or assumptions; for example, he cites many experiments on speed and accuracy and on increase of production from better lighting These are sound and reliable data. On the other hand in the same book, he makes statements such as,

> . . . approximately 70 percent of muscular activities are due to impulses received from the eyes . . . one-fourth of the consumption of the bodily energy is due to seeing, p. 11 . . . at least 40 percent of the population has defective vision. The percentage increases with age until, during the last third of the normal span of life, most persons have defective eyesight. . . . Most of this is preventable but is not prevented because consciousness of lighting and vision is not awakened owing to their commonplaceness. . . . It is inconceivable that eyes, to be used in the daytime, were not almost perfectly made for daylight, p. 3.

Such statements have a place in a popular work to arrest the attention of non-scientific readers. It is only necessary to discriminate, in reading such a work, between the facts and the assumptions.

Visual-comfort and visual-health criteria: Ferree and Rand have made many experiments and have drawn sound deductions about direct, semi-indirect, and indirect lighting as they affect visual comfort and efficiency. Most of these appeared in the Transactions of the Illuminating Engineering Society; for example, No. 6, in 1915, "Further experiments on the efficiency of the eye under different conditions of lighting," but there are many other papers. On the effect of sources of different wave lengths showing the superiority of Mazda (yellowish) to bluish daylight bulbs, published in the same journal in February, 1918: "Some experiments on the eye with different illuminants." The paper on "Lighting and hygiene of the eye in "The Archives of Ophthalmology, of July, 1929, is a summing up of much of the work of Ferree and Rand.

Ferree and Rand have been frequently quoted in support of many of the opinions expressed in this article and, since in some quarters discredit has been cast on their work, it may be well to present both sides of the question, for it is our wish that ophthalmologists should be qualified as far as possible to form their own intelligent opinions. In 1911, Dr. Ferree, professor of psychology at Bryn Mawr, was invited by a committee of ophthal-

mologists to coöperate in a study of the effects of different lighting systems on the eye. He was not subsidized directly or indirectly by any commercial organization or individual. The work was a part of the research work done in his laboratory at Bryn Mawr, unbiased by outside influences.

In order to show loss of efficiency after three to four hours' work under unfavorable lighting conditions there were, he said, three possible tests—(1) color discrimination; (2) brightness discrimination; (3) visual acuity. He found (1) and (2) unsuitable and (3) as *ordinarily applied* also unsuitable. He therefore devised a method of incorporating a time factor in the test, and settled finally in the "li test." The observer looks steadily at the letters li, 8-pt. size, at a distance nearer than the farthest point at which they are easily visible, usually 75 cm. or thereabout. Numerous details must be carefully observed in applying the test.

In interpreting this test, he said (Trans. I.E.S., v. 8, p 47):

"The muscular effort required to keep the eyes adjusted for clear vision cannot be sustained for the whole time. The test objects are seen alternately as clear and blurred."

Again on page 52, he says the test is

"A test of the refraction mechanism and its muscular control."

"Since the refraction mechanism could not change in three to four hours' work, the loss of efficiency must be a loss of muscular efficiency. This fits the facts already shown, that color discrimination and brightness discrimination, tests of retinal efficiency, did not show conclusively any loss. . . . The retina is conceived of as a mechanism more or less compensating in its action, while the muscles of the eye are not so considered."

And again,

"The net result is excessive muscular strain which soon shows itself in loss of power to do work."

After describing a test for fixation it is stated (on page 490, v. 10, Trans. I.E.S.):

"It does not seem to us at this time that loss of efficiency can be ascribed to any great extent to the muscles of fixation."

That the impression given by the first presentation of his work was that Ferree interpreted the periods of blur of the test object as dependent on the "muscle control" of the refraction mechanism—what we call accommodation—is further shown by the discussion (Ives p. 59):

"Then when the tired muscles flag and the object blurs. . . ."

At this time, I visited Ferree's laboratory at Bryn Mawr and having received the impression that the li test would serve as a test of fatigue of accommodation, in which subject I was particularly interested at the time, I set up at Harvard Medical School a careful reproduction of the Ferree apparatus. I was greatly disappointed to find that the test was not a test of accommodation and could not be used in our research (Lancaster and Williams, New light as to the theory of accommodation. Trans. Amer. Acad. of Ophth. and Oto-Laryng., 1914).

I was able to show that one could look at the li for three minutes or even much longer *without any* period of blur. It is only necessary to keep the eye moving from one part of the fixation object to another. The periods of blur occur only if the eye is kept stationary and is then purely a retinal affair and not due to any failure of focus—not a "test of the refraction mechanism and its muscular control" at all but a phenomenon of the way the retina functions.

In explaining this in my discussion of the next paper by Ferree and Rand (Trans. I.E.S., v. 10), I pointed out that

the erroneous interpretation of the phenomenon in no way vitiated its value as a test of the effect of lighting on the ability of the eyes to sustain work. The true criterion of that was in the reproducibility of the results and the very small mean variation (1 percent or even less). While Ferree made no acknowledgment of his error, he never again referred to the test as a test of the refraction mechanism and its muscular control but always as a "test of ocular efficiency."

Some years later, Drs. Cobb, Moss, and Luckiesh made a study of the li test and obtained such wide variation in their results that they pronounced the test worthless. It *is* worthless when conducted as they conducted it. It requires carefully trained observers and not all observers can be used even after careful and prolonged training. Very exact attention to many details is indispensable. The results obtained by Ferree and Rand are consistent and convincing. *Most important is the fact that their conclusions are confirmed by the laboriously accumulated experience of innumerable engineers and other observers and experimenters.*

Moreover, Ferree and Rand did not by any means limit their investigation of lighting to the use of the li test. Their test using the threshold of discomfort and the test with the tachistoscope and other tests gave important results; which, however, did not contradict but confirmed the results of the li tests.

It is my opinion that Ferree was able to answer the criticisms of Cobb, Moss, and Luckiesh, since these investigators did not conduct the test as Ferree and Rand conducted it. For example, Lancaster and Williams showed that fine movements of fixation, so small that they were always inside the area of the test object, li, sufficed to abolish the periods of blur altogether. Obviously, any use of the test which did not guard against movements of fixation would give worthless results. Various other details are described by Ferree and Rand in their reply to the paper by Cobb, Moss, and Luckiesh in the Transactions of the Illuminating Engineering Society.

My own opinion is that most of the conclusions reached by Ferree and Rand are well founded.

520 Commonwealth Avenue.

REMOVAL OF LEAD SHOT FROM THE VITREOUS BY USE OF THE BIPLANE FLUOROSCOPE*

W. E. Borley, M.D. and Edward Leef, M.D.
San Francisco

Since the advent of the roentgen ray, a new field has been opened to the ophthalmologist concerning both diagnosis and treatment of intraocular foreign bodies. The older textbooks, published before radiological methods were applied in the endeavor to solve this problem, showed how pessimistic the ophthalmologists of those days were in regard to this type of case. Norris and Oliver[1] in their textbook of ophthalmology, published in 1893, briefly describe the procedures carried out in attempting removal of these foreign bodies and give statistics on cases of extraction by magnet. They cite Hirschberg's series of 100 magnet extractions, 64 of them of intraocular foreign bodies. In these 64 cases of removal by the magnet only four patients retained normal vision. In addition to this there is mention of gunshot wounds of the eyeball with retention of the lead shot in the vitreous, but no method is proposed for their removal. They state that "when a small-sized bird shot has penetrated the eye it causes so great destruction at the point of entrance (and of exit if it passes through the orbit) with so much intraocular hemorrhage that eyesight is always seriously impaired and usually irretrievably lost."

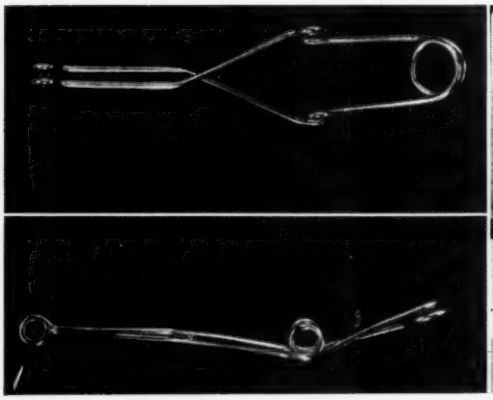

Fig. 1 (Borley and Leef). Cross forceps.

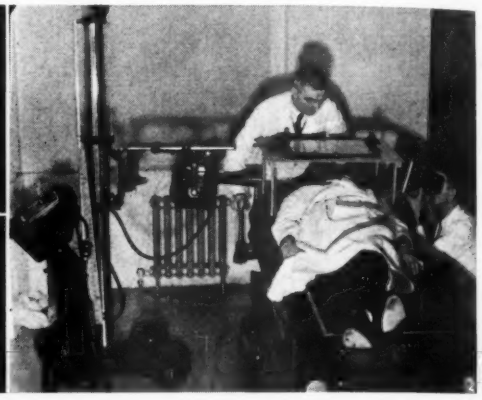

Fig. 2 (Borley and Leef). X-ray unit for biplane fluoroscopy.

The first successful demonstration of an intraocular foreign body by the roentgen ray was made in 1896 by F. H. Williams[2] of Boston, when the shadow of a fragment of copper cartridge was shown on a plate. This was removed from within the eyeball through a scleral incision, but sight was eventually lost. Previous to this it was thought that the eyeball was impermeable to X rays. In the next few years, many methods for localization of foreign bodies were offered. Accurate localization was made possible by 1909, when Sweet[3] described his new and improved method.

With all these improved methods of localization, however, the problem of removal of nonmagnetic foreign bodies was

* From the Departments of Ophthalmology and Radiology, Stanford University Medical School.

still baffling and until recent years no method was known that offered even a fair chance of success. Many isolated reports are to be found in the literature of attempts to remove these nonmagnetic intraocular foreign bodies, such as bits of brass, copper, stone, glass, wood, and lead. In the successful cases the usual method of effecting removal was through a posterior scleral incision with various types of forceps while observing the manipulations through the pupil with the ophthalmoscope. As recently as 1927 the general attitude of most ophthalmic surgeons may be summed up in a paper by E. C. Ellet[4] on "Wounds of the eye by projectiles of small caliber and low velocity" as follows: ". . . these cases (referring to bird shot) present probably the simplest problem. Such an eye is almost always lost as an organ of vision, and even more than in the cases of the through-and-through wounds is it apt to pass into a state of chronic inflammation. . . . The situation is complicated by the fact that the small shot . . . are nonmagnetic and offer only the slightest hope of removal."

Mention of the use of double-plane fluoroscopy in connection with removal of nonmagnetic bodies in the vitreous was first made by Cross[5] in a paper presented by him before the American Ophthalmological Society in 1927. In 1926 a patient came to him with a lead shot in an only eye. The media were cloudy so he could not use the ophthalmoscope to localize the foreign body. His method of effecting removal consisted, briefly, in procuring accurate localization with the X-ray films first and then working under the biplane fluoroscope with a small cross-action, ring forceps (fig. 1) through a scleral incision and under the direction of the radiologist. A number-six lead shot was removed in this way, and the eye was left with the same vision as before operation, namely, light perception. Between 1929 and 1931 five additional cases were reported by Cross, [6, 7, 8] in one of which the patient subsequently developed a detachment of the retina. In another case a particle of of cartridge was extracted with a small mosquito forceps under double-plane fluoroscopy. In 1935 Cross[9] reported on his original case before the annual meeting of the Medical Society of the State of New Jersey; he also stated that 18 patients in all had been operated on by this method, when the foreign body was in the eyeball. In a number of these cases, bits of copper or other metal were removed by similar or slightly different forms of forceps. No further cases of removal by the Cross method have been reported to the present time. However, Harvey E. Thorpe,[10, 11] in 1934 and 1936, described the ocular endoscope and a new forceps of the cross-action ring type to be used in conjunction with the endoscope. No cases were reported by him.

Since the occurrence of nonmagnetic intraocular foreign bodies, particularly of the lead-shot variety, is not so infrequent, it seemed to us worthwhile to report the following case. In this instance a number 7½ lead shot was removed by the Cross method, with certain modifications which we believe to be important in the prevention of serious postoperative complications.

Case Report: A.M.P., 50 years old, an American business man, was referred by Dr. Dwight H. Trowbridge, Jr., of Fresno. The patient was hunting quail on November 15, 1936, with friends and was struck in the face by a scatter of shot from some little distance. Two shot struck the right side of his face, one entering the right eyeball just behind the ciliary body on the nasal side, the other penetrating the orbit to the temporal side of the eyeball. The conjunctival wound over the ciliary body was sutured by Dr. Trow-

bridge and the eye treated expectantly until the acute inflammation subsided, about the first of January, 1937. On examination, January 12, 1937, the right eye had only faint light perception, the left eye 20/20 vision. The right eyeball was minus one in tension, showed slight circumcorneal injection, and the lens and aqueous were clear; but the anterior vitreous layers were cloudy, being diffusely infiltrated with a brownish pigment deposited in fine dustlike particles. The fundus could not be seen. X-ray localization by one of us (E. L.) using the Sweet method showed two small shot, one in the eyeball eight millimeters behind the center of the cornea, six millimeters in the plane below and four millimeters to the nasal side. The other shot was localized against the outer bony margin of the orbit.

An attempt at magnetic extraction was unsuccessful and as it appeared that the eyeball would be lost if the foreign body were allowed to remain in place the patient was given the choice of enucleation or an attempt at removal of the shot. He was told that even if the shot were removed successfully the eye might not heal and enucleation might be necessary. He preferred to take the chance at operation, however, and so, after considerable experimentation with various methods on a cadaver with bi-plane fluoroscopy, the writers operated on January 14, 1937.

A biplane fluoroscope as a single unit was not available. However, biplane fluoroscopy was made available by using the table fluoroscope and the mobile X-ray unit. The screen support and screen were removed from the table fluoroscope to make room for the mobile unit for horizontal flouroscopy. The table fluoroscopic screen was then remounted on a stand, as shown in figure 2. We were thus equipped for biplane fluoroscopy. Inasmuch as none of us had had any experience in the extraction of ocular foreign bodies with fluoroscopic control it was necessary to gain some practice on a cadaver. Accordingly, a similar shot was placed in the cadaver eye that had been inflated with KY jelly to simulate the size and consistency of a normal eye (fig. 3, 4). Using the two fluoroscopes simultaneously and alternately (70 kv., 4 ma.) the observer (E. L.) could direct the operator (W. E. B.) so that the latter was able to grasp the shot with his instrument and remove it. The grasping instrument was so constructed that it would remain open with slight pressure, and close when the pressure was released. This small forceps (fig. 5) was made of no. 18 silver

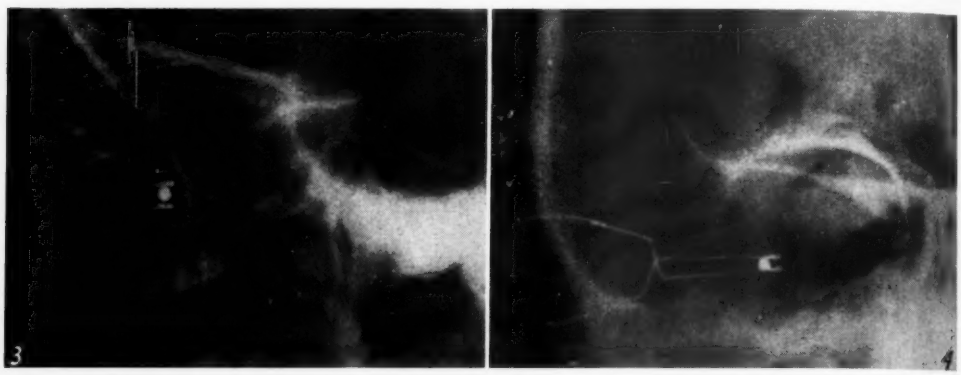

Fig. 3 (Borley and Leef). Lateral view showing lead shot grasped by forceps.
Fig. 4 (Borley and Leef). Anterior view showing lead shot grasped by forceps.

wire, fashioned by Dr. Newell into an instrument somewhat similar to the one used by Dr. Cross. After much practice upon the cadaver a fair proficiency in extracting the lead shot was gained and we were ready for the patient.

The preoperative sedative consisted of three grains of sodium amytal on the night before and repeated at seven o'clock on the morning of the operation. One grain of codeine was given by hypodermic when the patient was called to the operating room. The operation consisted of two stages: that in the operating room, and the actual removal of the shot in the fluoroscopic room of the Department of Radiology. In the first stage in the operating room, the eye was anesthetized with 4- and 10-percent cocaine and retrobulbar injection of 2½ c.c. of 1-percent novocaine. A black-silk suture was placed in the superior rectus to control the motion of the eyeball. A few minims of 1-percent novocaine were then injected over the external rectus and slightly below this area. A conjunctival incision 10 millimeters long was made between the external and inferior recti, 10 millimeters behind the limbus in an equatorial direction. The sclera in this area was freed of episcleral tissue and a circular area about the line of the proposed scleral incision prepared by microcoagulation as a precautionary measure directed against retinal detachment. With a single sharp electrode and 50 to 60 milliampere current, and using the Walker diathermy machine (for retinal-detachment operations), a series of coagulations, one to two millimeters apart, was effected, care being exerted to avoid perforation of the sclera. This procedure was suggested to one of us (W. E. B.) by Dr. Dohrmann Pischel who had carried it out in a case in which a copper fragment was removed from the vitreous after accurate localization with the ophthalmoscope. Following this, two fine, black-silk sutures were

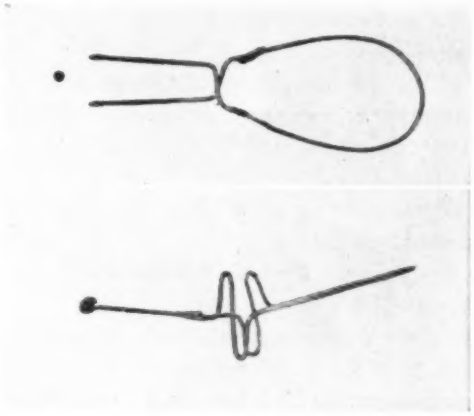

Fig. 5 (Borley and Leef). Forceps used in this case.

placed one millimeter apart in the superficial scleral tissue at the center of the circle of coagulation. The speculum was removed and the eye and face covered with sterile towels. The patient was then taken to the flouroscopic room and placed on the table as shown in figure 2.

One of us (W. E. B.) made a radial incision through the sclera 5 millimeters in length, 10 millimeters posterior to the limbus between the black-silk sutures. Gentle traction was made on the silk sutures to separate the wound edges and the forceps was inserted into the vitreous cavity with the blades closed. It was then turned at right angles and opened. Then under biplane fluoroscopic control the manipulation of the open instrument was directed until it was over the lead shot in both planes, the instrument was closed and removal was attempted. The forceps was withdrawn nearly to the wound when the shot slipped out of the rings and could be seen returning to its original position as if it were on a rubber band. We concluded from this that the shot was encased in exudate or fibrous vitreous adhesions. A firm grasp was taken on the shot again without difficulty and this time, after turning on the lights, it was withdrawn to the wound. The adhesions were cut with DeWecker scissors behind the

shot and it was easily removed from the eye.

The scleral silk sutures were then brought through the conjunctiva and tied. The eye was closed and both eyes were padded.

The postoperative care consisted of daily dressings after the first two days. One-percent atropine-sulphate ointment was instilled daily.

There was considerable subconjunctival edema at the first dressing, on the second post-operative day, but no evidence of a severe intraocular infection. On the patient's dismissal, January 20, 1937, there was no pain, the eye was slightly injected, tension about as before operation, and the pupil was moderately dilated.

The patient was last seen March 15, 1937, at which time the eyeball appeared to be about the same. Tension was practically normal. The fundus could not be seen. Vision was faint light perception.

Summary

A case of intraocular lead shot is presented.

Extraction was possible by means of the Cross method, using his cross-action ring forceps under bi-plane fluoroscopic control.

A review of the literature is given and a modification of the Cross operation suggested.

The operation was divided into two stages; the first was performed in the operating room, the second in the fluoroscopic room. Microcoagulation of the area of sclera and choroid through which the shot was removed was completed in the operating room, and actual incision of the sclera was carried out in the fluoroscopic room.

Diathermic treatment to the sclera was applied, with the scleral incision posterior to the ciliary body. By this means the complications of injury to the ciliary body and of retinal detachment are considerably lessened.

The importance of early operation is shown by the occurrence in this case of vitreous adhesions, a low-grade plastic inflammation resulting from the retention of the foreign body over a period of two months.

The patient retained a fairly normal-appearing eyeball, with only light perception. No severe intraocular infection followed operation.

Conclusions

(1) It is possible to remove lead shot or other nonmagnetic intraocular foreign bodies with the help of the double-plane fluoroscope. (2) The serious complications of retinal detachment, which frequently follow extraction of these foreign particles, may be prevented by application of diathermic microcoagulation. (3) Early operation is essential to the maintenance of good vision.

We are grateful to Dr. R. R. Newell, chief of the Department of Radiology for his aid and suggestions, and to Dr. A. M. Clark, resident in Radiology for his aid in fluoroscopy.

References

[1] Norris, W. F., and Oliver, C. A. A textbook of ophthalmology. Lea Bros. Co., 1893, pp. 296-299.

[2] The American encyclopedia of ophthalmology. 1917, v. 10, p. 7503.

[3] The American encyclopedia of ophthalmology. 1917, v. 10, p. 7512.

[4] Ellett, E. C. Wounds of the eye by projectiles of small caliber and low velocity. Trans. Amer. Ophth. Soc., 1927, v. 25, p. 64.

[5] Cross, G. H. Removal of no. 6 lead shot from within the eyeball by specially designed forceps with the aid of the double plane fluoroscope. Trans. Amer. Ophth. Soc., 1927, v. 25, p. 80.

[6] ———. Removal of a no. 8 lead shot from the vitreous with 20/20 or 6/6 vision in one case. Trans. Amer. Acad. Ophth. and Otolaryng., 1929, p. 173.

[7] ———. Removal of lead shot from the vitreous. Amer. Jour. Ophth., 1930, v. 13, p. 41.
[8] ———. Removal of non-magnetic foreign bodies from the vitreous. The Pennsylvania Med. Jour., 1930-31, v. 34, p. 480.
[9] ———. Intraocular non-magnetic foreign bodies with special reference to their removal. Jour. Med. Soc. of New Jersey, 1935, v. 32, p. 697.
[10] Thorpe, H. E. Ocular endoscope. Trans. Sec. Ophth. Amer. Med. Assoc., 1934, p. 290.
[11] ———. A new forceps for removal of lead shot from the vitreous. Arch. of Ophth., 1936, v. 15, p. 308.

RECENT ADVANCES IN THE SURGERY OF CHRONIC GLAUCOMA*

OTTO BARKAN, M.D.
San Francisco

Preliminary report of a new surgical procedure for glaucoma, consisting of operating on Schlemm's canal under direct magnified vision, was presented before the Section on Ophthalmology of the American Medical Association,[1] and read before the Association for Research in Ophthalmology at Kansas City, in May, 1936.[2] In this article the subject matter is approached from another point of view and certain observations and deductions on the pathologic-anatomic entity of chronic simple glaucoma are added in the hope that they may be verified by other observers.

FACTORS OF SUCCESS IN SURGERY

Success in surgery is dependent largely on two factors: knowledge concerning the cause of the disease and the direct visibility of the area under operation.

It has been the constant aim of surgeons to gain visual access to the hidden recesses of the human body. These efforts have been successful in various regions through invention of instruments which, by means of mirrors, prisms, and improved sources of light, deflect the incoming and outgoing rays in such manner that the surgeon is afforded direct vision in a field of operation which was formerly hidden from view. Largely because of these methods, permitting operation under direct vision, successful surgery of the larynx, bronchi, urinary bladder, prostate gland, and other regions has been made possible.

OBSTACLES TO THE SUCCESSFUL SURGERY OF CHRONIC GLAUCOMA

The surgery of glaucoma has not kept pace with these advances. Ophthalmologists have continued to labor under two great handicaps: first, the lack of knowledge of the cause of the increased intraocular pressure, and, second, the necessity of operating blindly or semiblindly. After incision of the external tunic of the eye is made in an operation for glaucoma, the further course of the procedure is hidden from view by the opaque scleral limbus. Thus the surgeon cannot see, he can do little more than guess, what effect his instruments will have inside the eyeball. He likewise does not know the cause of the condition he is attempting to relieve.

RESULTS OF RECENT INVESTIGATIONS

These handicaps, it would appear, have in large measure been overcome in the majority of cases of chronic glaucoma[2] (chronic glaucoma type 1 of the writer, or the so-called chronic simple glaucoma) by:

*Read before the annual meeting of the American Academy of Ophthalmology and Otolaryngology, New York City, September 29, 1936.

1. Establishing the mechanical cause of the increased intraocular pressure. Slit-lamp biomicroscopy of the angle of the anterior chamber shows the pores of the in outflow through the pores of the trabeculum. This trabecular block has been found to be present in all cases of chronic glaucoma type 1 (chronic simple glaucoma) examined biomicroscopically to date.

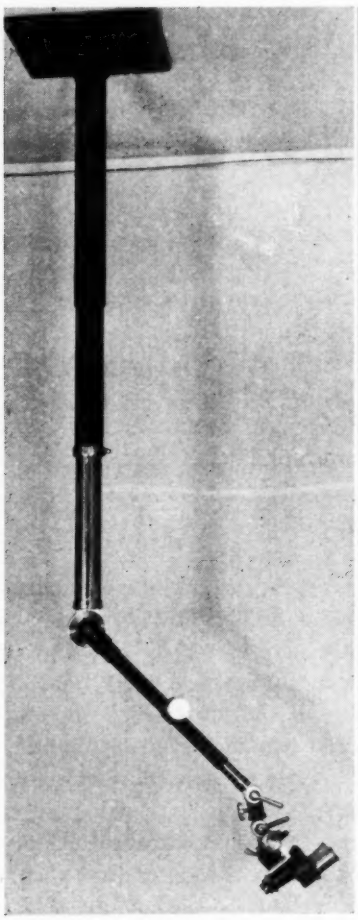

FIG. 1

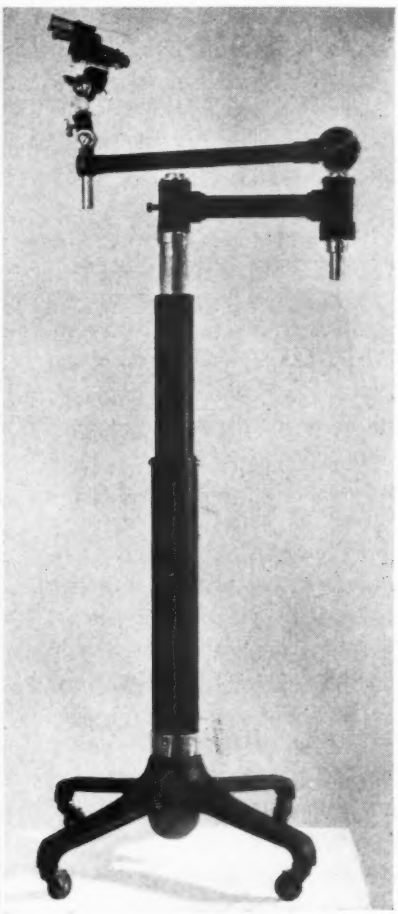

FIG. 2

Fig. 1 (Otto Barkan). Binocular micro-gonioscope—ceiling suspension model.

Fig. 2 (Otto Barkan). Binocular micro-gonioscope—floor model.

corneoscleral trabeculum to be blocked in this type of case.[3] Removal of the blocked trabeculum by the author's procedure of opening Schlemm's canal under direct vision reduces to normal the increased intraocular pressure. The result of the operation indicates that increased intraocular pressure is the direct result of stoppage

2. Operation under direct vision and removal of the cause of the increased intraocular pressure. The blocked trabeculum is incised from within the eyeball, the trabeculum being maintained under full view during the operation by means

of a contact glass devised by the author for this purpose. The physiological direction of outflow of aqueous from the anterior chamber into Schlemm's canal is thus restored.

A similar approach to the angle across the anterior chamber was used by the Italian, DeVincentiis, in 1891.[4] He, however, carried out his procedure unable to see where his knife was going. The operation was later abandoned.

Biomicroscopy of the Angle of the Anterior Chamber

The technique of slitlamp biomicroscopy of the angle, which was devised for these investigations and which was used to establish the preoperative diagnosis, has been published in a previous article.[3] Since then, the ceiling model therein described has been improved through the adoption of various mechanical devices in order to make it even more flexible while maintaining its steadiness and decreasing its weight (fig. 1). In addition to this model, which has the advantage of not occupying floor space, a simplified unit has been devised for use on a movable floor stand (fig. 2). This floor unit is equally flexible and has the advantage that it may also be used as a corneal microscope for routine examination of the anterior segment while the patient sits upright or reclines in a treatment chair with head rest. Both units may be fitted with the top of either a Zeiss or Bausch and Lomb corneal microscope. The use of 2 × objectives and 10 to 12½ × oculars when combined with the refractive power of the eye and the contact lens afford a total magnification of up to nearly 40 ×. This technique, in the opinion of the writer, will be found far superior to and much simpler than any of the previous gonioscopic methods used to examine the angle of the anterior chamber.

As the blocked trabeculum (the trabecular pigment band of the writer, fig. 3) and the thickening or sclerosis of the trabeculum have not been described before with the gonioscopic methods of the past, they would seem to be inadequate. It seems necessary, therefore, for the satisfactory investigation of these structures to use a technique which will show, as does the one mentioned above, details of the trabeculum and of the trabecular pigment band.

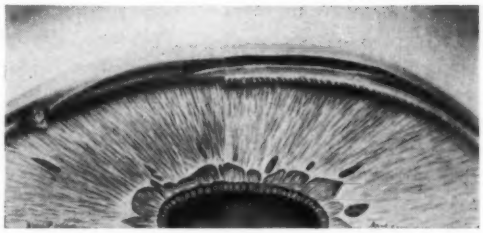

Fig. 3 (Otto Barkan). Drawing representing incision of the trabeculum or opening of Schlemm's canal as it appears upon examination with the writer's micro-gonioscope. The trabecular pigment band is shown at the beginning and the end of the incision. The small lump at the left consists of coiled-up remnants of trabeculum.

Magnification. For purposes of quick inspection and orientation, the angle may be conveniently viewed through the contact lens with an ordinary binocular 5-diopter head loupe. This affords 2 × to 3 × magnification. For greater detail, however, the biomicroscopic technique described above should be used as routine, just as the corneal microscope is routinely used for examination of the anterior segment.

Illumination. The angle of the anterior chamber may be advantageously illuminated in two ways:

1. By direct illumination, in which the incident beam comes from more or less the same direction as the line of regard of the observer.

2. By indirect or transscleral illumination, in which the beam comes from the opposite direction and traverses the sclera

on its way to the angle, thus transilluminating it ("posterior gonioscopy" of Trantas).

In using direct illumination and for purposes of orientation and observation of a relatively large field, the Shahan hand lamp, with a beam 5 to 10 mm. in diameter, will answer the purpose. Detail is enhanced by cutting down the beam of light to a slit. For actual biomicroscopy, a Vogt carbon-arc slitlamp is used, mounted on an adjustable stand. Transillumination is obtained with the narrow beam of the Shahan hand lamp cut down to a spot 3 mm. in diameter. Improved devices for the illumination of the angle of the anterior chamber are being developed and will be described in the near future. Castroviejo[5] has recently described a light attached to the head of the microscope which he has used for the purpose of photographing the angle and examining it, the microscope being held in the hand.

Chronic simple glaucoma as a pathologic anatomic entity

The writer believes that the group of cases in which this operation "under direct vision" has proved to be especially indicated and effective and which he has classified as chronic glaucoma, type 1, constitutes a sharply circumscribed pathologic-anatomic entity. This entity appears to cover the hitherto somewhat ill-defined clinical picture of "chronic simple glaucoma." It furthermore appears to correspond to the clinical conception of "anterior glaucoma," which would seem to indicate that the latter is identical with "chronic simple glaucoma." In all cases of this group examined biomicroscopically to date, a block of the trabeculum appears to be the mechanical cause of the increased intraocular pressure.

As a result of these investigations which included, in addition to the usual examinations, (1) measurement of the depth of the anterior chamber with Ulbrich's drum micrometer, (2) biomicroscopy of the angle of the anterior chamber with the author's technique, and (3) observation of the effect of reëstablishing the communication between the anterior chamber and Schlemm's canal by operation under direct vision, it would seem that a definite pathologic entity has crystallized. In its early and uncomplicated stage and even in the last stage of blindness and absolute glaucoma, the following characteristics are noted:

1. The depth of the anterior chamber is normal or only slightly reduced.

2. The angle is open.

3. The pores of the trabeculum are blocked. This block is apparent usually as an infiltration with pigment granules that forms what the writer has termed the trabecular pigment band. When, as is sometimes the case, little or practically no pigment is present it may still be inferred that a block of the pores exists, from the definite thickening of the trabeculum, as shown by its lack of transparency to the beam of the slitlamp and from the pressure-reducing effect of opening the canal by incising the trabeculum. The cause of this sclerosis or impermeability of the trabeculum and of the block of its pores with pigment has not been determined. One wonders what the physicochemical constitution of the aqueous may be, what hormonic, dietary, infectious, or autonomic factors may be at work in these cases, or what effects are produced by a disease of the end arteries that supply the region of the canal of Schlemm.[6] It is interesting to note, in passing, that a theory of pigment glaucoma was, in the past, suggested on the basis of infiltration of the angle with pigment, as observed in anatomic sections by Levinsohn,[7] inter al, and of dissemination of pigment on the inner lining of the anterior segment as observed by Koeppe[8] with the corneal microscope and slitlamp. Studies of ana-

tomic sections led Henderson[9] to suggest a sclerosis or fibrosis of the cribriform ligament (corneoscleral trabeculum) as a primary cause of glaucoma.

4. There is occasional atrophy of the pigment epithelium of the iris, or more rarely exfoliation of the lens capsule (Vogt[10]).

5. Glaucomatous excavation of the optic nerve is present.

Trabecular pathology as the cause of increased intraocular pressure

Further evidence that a block of the trabeculum is the primary mechanical cause of the increased intraocular pressure in chronic simple glaucoma and not a result of it is shown by those cases in which the pigment block is present not only in the affected eye but also in the healthy fellow eye, which shows not the slightest other sign or symptom of early glaucoma. The uninvolved eye also responds normally to all other clinical tests, including provocative tests and diurnal tension curves. It is worthy of particular note that *trabecular pathology is present in these otherwise apparently healthy fellow eyes before increased tension becomes evident.* The reason for this would seem to be that the stoppage of the pores has not yet advanced to the point of blocking outflow sufficiently to cause retention of intraocular fluid or to cause, reflexly, excess formation of fluid through an increased vascular response. The latter, when it does occur, may be interpreted as an attempt to overcome the block and maintain normal metabolic exchange.[11]

Early diagnosis

It is evident that the biomicroscopic method of examining the angle often allows a much earlier diagnosis of chronic simple glaucoma than has hitherto been possible, for, as has been stated, certain signs of the disease, such as pathological change in the trabeculum, may be present long before there is any increase in pressure. The increased intraocular pressure would seem to follow in point of time and to be secondary to the mechanical result of the glaucomatous disease.

On the etiology and symptomatology of chronic simple glaucoma

The cause of the sclerosis and of the stoppage of the pores of the trabeculum in this type of glaucoma (type 1) is, as stated above, as yet a matter of conjecture. It would seem, at the present time, to be a matter of greater practical importance to establish and confirm the mechanical cause of the increased intraocular pressure, since a mechanical derangement can be relieved by surgical means, thereby preserving the function of the optic nerve.

Usually no subjective congestive symptoms, such as haloes, mists, fogs, or pain, are associated with the retention of intraocular fluid and increase of intraocular pressure in type 1. A reason for this would seem to be that the very gradual rate of formation of the block and the subsequent gradual onset and slow rate of increase in intraocular pressure afford sufficient time for the ocular apparatus to compensate and adjust itself to the new order of things.

The meager precipitation of pigment from the clear aqueous and the correspondingly slow rate of its deposition to form the trabecular pigment band in chronic simple glaucoma may be regarded as analogous to the gradual process of sedimentation occurring over the course of many years in a slow stream of very clear water. This conception illustrates the slowness of development of the trabecular block and accounts for the slow rate of increase in intraocular pressure over the course of many years; also for the equally slow rate of excavation of the optic nerve; for the remarkable adjustment of the local vascular system and the develop-

ment of a collateral circulation within the eyeball, and for the psychological adjustment of the individual himself to what may ultimately be an extremely high degree of mechanical block and of increased intraocular pressure. It would seem to account also for the practically asymptomatic course of the disease, for which reason it bears the name "simple glaucoma." It would seem probable, then, that this remarkable physical adjustment within the eye with its concomitant absence of subjective symptoms explains the well-known psychological adjustment of the individual as a result of which even an intelligent person not uncommonly loses the function of half or more of the optic nerve of one eye before he consults an oculist. Such is the insidious and dangerous nature of this disease. No alarm is sounded, in the form of congestive symptoms, to warn the individual of increase in intraocular pressure or of progressing atrophy of the optic nerve and of impending blindness. In chronic glaucoma type 1 the eye undergoes a slow process of pressure atrophy, which is hardly ever associated with symptoms. When subjective symptoms and objective signs of congestion occur, which they may do rather exceptionally, they appear to be the result of an increase of the vascular response, and of an increased instability of local circulation of blood; in other words, a change in the vasomoter factor rather than change in the rate of excretion or in the extent of the block of the outlet. This interpretation I believe holds true in type 1 until its later stages, in which it appears that peripheral adhesions of the iris may occasionally form, and the eye is in the stage of venous decompensation. In these later stages of type 1, including "absolute glaucoma," the local intraocular arterial and venous blood pressures are increased sufficiently to withstand the increased pressure of the intraocular fluids upon them. As a result of this, and through the development of a collateral circulation, the episcleral vessels dilate and a "caput medusae" may form. Yet even in this late stage congestive symptoms are not infrequently lacking when the angle is open, and the pathologic anatomic picture is essentially the same as it was in the early stage except in degree.

Operative results

In chronic simple glaucoma (type 1 of the writer) the increased intraocular pressure has been reduced to normal in every one of the 20 patients operated on to date in which postoperative biomicroscopic examination showed Schlemm's canal to have been opened over a sufficient extent of its circumference (about one fourth). In a few cases in which the canal was missed the pressure remained unchanged. In others in which only a small part of the circumference of the canal was opened the pressure was only partially reduced. In those cases in which the patient was again operated upon, and the canal was opened, the tension was normalized.

Nomenclature

For practical use and for the sake of brevity it would appear advisable to give a name to this procedure of opening Schlemm's canal under direct vision. I have on past occasions spoken of it as "goniotomy." A more apt and descriptive term for it, would, I feel, be "trabeculotomy" for the operation consists precisely of an "incision of the trabeculum." An even more comprehensive term would be "gonio-trabeculotomy."

Indications

It is worthy of note that the reduction to normal of the increased intraocular pressure that occurs following this operation is independent of its extent before operation. As the degree of increase in intraocular pressure does not appear to be in direct relation to the type of glaucoma,

it should not, in itself, be taken into consideration when choosing the type of operation for a given case. The pathologic-anatomic type should rather be considered and the operation chosen according to it. Incidentally, in this connection, and as a matter of fact, the operation of opening Schlemm's canal does happen to be particularly adapted to cases in which there is a high degree of increased intraocular pressure, for only a puncture of the anterior chamber is made, no aqueous is lost, and there is consequently no sudden reduction of pressure with its well-known dangers.

In the present state of our knowledge, and judging by the writer's experience during the past year with this procedure, it would seem to be the operation of choice and worthy of trial in all cases of chronic glaucoma type 1 with open angle (chronic simple glaucoma), irrespective of the degree of tension. External filtering operations, iridectomy, or cyclodialysis would still seem to be indicated, at the time of this writing, in chronic glaucoma type 2[3] and in those cases which constitute the later stages of type 1 and type 2, in which organic peripheral adhesions of the iris have formed and signs of venous decompensation have supervened.

The importance of biomicroscopy of the angle for the management of chronic glaucoma

The angle of the anterior chamber has, up to the present time, remained a much-neglected region in spite of the important investigations that have been published over the course of many years by a small group of workers in this field. Among these may be mentioned in Europe, Trantas,[12] Salzmann,[13] Koeppe,[8] Thorburn,[14] Werner,[15] Vannas,[16] among others, and in this country Uribe Troncoso,[17] and more recently Castroviejo,[5] and Bruce.[18] Great credit is due Uribe Troncoso for his important investigations and contributions in this field. To have acquired an intimate knowledge of the angle in the living has remained the distinction of this small group of investigators. It would seem that the inadequacies and difficulties of the "gonioscopic" methods of the past have prevented their more extensive adoption and popularization. So, it happens that when speaking of glaucoma the ophthalmic surgeon of today, who has never seen and is unfamiliar with the region of the angle in the living, is more apt to visualize the external aspect of the limbus where he makes his incision rather than the inner aspect of the angle where the incision takes effect and where the functionally all-important structures are located. Interesting gonioscopic observations of trephined cases have been made by Troncoso and Reese.[19] Biomicroscopic examination of the effects of surgery on the topography of the angle as well as on its individual and neighboring structures, the iris, ciliary body, zonule, cornea and Descemet's membrane is highly informative. *The importance of visualization of the angle in the living by means of the binocular microscope (biomicroscopy) can hardly be overemphasized.* With the new technique of biomicroscopy the examination of the angle is rendered easy and swift for both observer and subject. It should, I believe, be used routinely in indicated cases, as the corneal microscope is used as routine for the examination of the anterior segment.

An intimate familiarity with the region of the angle of the anterior chamber will, I believe, be found to be of great value to every ophthalmic surgeon who operates within the angle either according to the blind or semiblind methods of the past, or uses the new procedure of operating under direct vision.

Summary

1. The procedure of opening Schlemm's canal under direct vision involves a new

principle in the surgery of glaucoma in that a hitherto hidden area of the inside of the eyeball (Schlemm's canal and the angle of the anterior chamber) is made visible during operation.

2. The surgeon can see the area of blockage during the operation and can actually watch and guide his instrument in restoring the normal direction to the circulation of intraocular fluid.

3. The operation is without danger when the proper technique is used and has proved successful when certain preoperative indications (biomicroscopic diagnosis) have been fulfilled.

4. The results are predictable and appear to be permanent. However, a much longer period of observation will be necessary to give a definite answer to the question of permanency of results.

5. The operation is especially indicated in chronic simple glaucoma (type 1 of the writer). It is equally successful in certain cases of secondary glaucoma and gives promise of being applicable also in certain other cases of primary glaucoma.

6. The pathologic anatomic entity described by the writer as chronic glaucoma, type 1, appears to cover "chronic simple glaucoma" and "anterior glaucoma."

7. Certain conclusions in regard to the etiology and symptomatology of chronic simple glaucoma may be fairly drawn.

8. Biomicroscopy of the angle of the anterior chamber is a useful adjunct to diagnosis and often enables an earlier diagnosis of glaucoma than has hitherto been possible. It would seem to constitute a considerable advance in the management of glaucoma.

9. The operation of opening Schlemm's canal under direct vision may assist in the solution of the surgical problem of chronic glaucoma.

490 Post Street.

Bibliography

[1] Barkan, Otto. A new operation for chronic glaucoma. Trans., Sect. on Ophth., Amer. Med. Assoc., 1936, pp. 244-248.

[2] ———. A new operation for chronic glaucoma: Restoration of physiological function by opening Schlemm's canal under direct magnified vision. Amer. Jour. Ophth., 1936, v. 19, pp. 951-966.

[3] Barkan, O., Boyle, S. F., and Maisler, E. On the genesis of glaucoma: An improved method based on slitlamp microscopy of the angle of the anterior chamber, Amer. Jour. Ophth, 1936, v. 19, March, pp. 209-215.

[4] De Vincentiis. Sulla incisione dell' angelo irideo. Ann. di Ottal., 1891, 1892, v. 20.
——— Incisione dell' angelo irideo nel glaucoma. Ann. di Ottal., 1893, v. 22.

[5] Castroviejo, R. Goniophotography. Photography of the angle of the anterior chamber in living animals and human subjects. Amer. Jour. Ophth., 1935, v. 18, June, no. 6.

[6] Friedenwald, J. S. Circulation of the aqueous. Arch. of Ophth., 1936, v. 16, July, no. 1, pp. 65-77.

[7] Levinsohn, G. Zur Entstehung des Glaukoms durch Pigmentinfiltration der vorderen Abflusswege des Auges. Zeit. f. Augenh., 1918, v. 40, p. 344; Arch. f. Augenh., 1908, v. 62, p. 130.

[8] Koeppe, L. Ueber den derzeitigen Stand der Glaukomforschung an der Gullstrandschen Nernstspaltlampe sowie den weiteren Ausbau des Glaukoms. Frühdiagnose vermittelst dieser Untersuchungsmethode. Zeit. f. Augenh., 1918, v. 40, p. 138.

[9] Henderson, T. Glaucoma. London, 1910.

[10] Vogt, A. (a) Ein neues Spaltlampenbild des Pupillengebietes: Hellblauer Pupillensaumfilz mit Häutchenbildung auf der Linsenvorderkapsel. Klin. M. f. Augenh., 1925, v. 75, p. 1. (b) Ein neues Spaltlampenbild: Abschilferung der Linsenvorderkapsel als wahrscheinliche Ursache von senilem, chronischem Glaukom. Schweiz. med. Woch., 1926, v. 56, p. 413. (c) Neue Fälle von Linsenkapselglaukom (Glaucoma capsulare). Klin. M. f. Augenh., 1930, v. 84, p. 1.

[11] Barkan, Otto. The structure and function of the angle of the anterior chamber and Schlemm's canal. Arch. of Ophth., 1936, v. 15, Jan., pp. 101-110.

[12] Trantas, A. Sur la gonioscopie (Ophthalmoscopie de l'angle irodocornéen). Arch. d'Opht., 1928, v. 45.

[14] Salzmann, M. Die Ophthalmoskopie der Kammerbucht. Zeit. f. Augenh., 1914, v. 31, and 1915, v. 34.
[15] Thorburn, S. Svenska Läk.-Sällsk. Handl., 1927, v. 53, pp. 252-272; and pp. 273-291.
[16] Werner, S. Gonioscopical studies of operated cases of glaucoma. Acta Ophth., 1931, v. 9, pp. 112-116; 1932, v. 10, pp. 426-583.
[17] Vannas, M. V. Zykloskopische Untersuchungen über das Verhalten des Strahlenkörpers nach der Heineschen Operation. Klin. M. f. Augenh., 1935, v. 95, p. 629.
[18] Troncoso, M. U. Gonioscopy and its clinical applications. A gonioscopical study of anterior peripheral synechiae in primary glaucoma. Amer. Jour. Ophth., 1925, v. 8, p. 433.
[19] Bruce, G. M. Visualization of foreign bodies in the irido-corneal angle. Arch. of Ophth., 1933, v. 10, Nov., pp. 615-620.
[20] Troncoso, M. U., and Reese, A. B. Gonioscopic findings after Elliott operation. Amer. Jour. Ophth., 1935, v. 18, Feb., pp. 103-119.

SOME TECHNICAL QUESTIONS IN CATARACT SURGERY*

WILLIAM F. MONCREIFF, M.D.
Chicago

Cataract surgery is a subject of such wide extent that an exhaustive discussion would require hours, and run to many thousands of words. The purpose of this short paper is to present the case for certain technical procedures, which are in accord with the following undoubtedly desirable criteria for the cataract operation, whether intra- or extracapsular, namely: (1) the restoration of normal or maximal vision; (2) reduction to a minimum of the risk attending the operative procedure and postoperative convalescence; (3) preservation of the anatomical integrity of the eye to the greatest possible extent; (4) the least restriction of the patient and the least interference with his comfort, especially during the postoperative period, that is compatible with safety.

The technical measures referred to are the following: (1) ciliary ganglion (retrobulbar) injection; (2) corneoscleral suture; (3) extraction without iridectomy, but when necessary with preliminary dilatation of the pupil; and when the operation is extracapsular, (4) capsulectomy with the sharp-toothed capsule forceps, and adequate mechanical removal of residual lens substance, especially by ample irrigation of the anterior chamber. The procedures just enumerated are omitted, singly or severally, from many a cataract operation, yet they all tend toward an ideal result, and, with the possible exception of the omission of iridectomy, their influence is toward the prevention of several important operative and postoperative complications and sequelae. Among these are especially vitreous prolapse, fistula of the wound tract, iris prolapse, postoperative uveitis, and secondary cataract.

Let us now consider in turn the case for and against each of the above-mentioned procedures, with reference particularly to the value of each for the prevention of complications, and for tending toward the most desirable type of result.

First, the ciliary-ganglion or retrobulbar injection of 4-percent novocain. The advantages are the exceptionally complete anesthesia, and the more or less marked temporary hypotony, which makes vitreous prolapse all but impossible, and which facilitates intracapsular extraction by the forceps method. The only disadvantage is

* From the Ophthalmic Service, Cook County Hospital, Chicago. Read before the Chicago Ophthalmological Society, November 16, 1936.

the very uncommon accident of retrobulbar hemorrhage.

Second, is the corneoscleral mattress suture, which is a most important feature of contemporary cataract surgery from the standpoint of safe and uncomplicated wound healing. This form of corneoscleral suture is the equal of any other single suture in securing a firm wound closure, and is the very simplest, I believe, of all types. Since this suture is inserted before making the section, its use is free from the trauma, hazards, and difficulties of those methods which place the sutures after the section is made. The corneal arm of the suture should be placed in most cases just at the margin of the vascular loops of the conjunctival vessels of the limbus, deeply enough to prevent cutting out of the cornea, and not deeply enough to encounter too much tissue resistance. The scleral arm is placed in a similar way some 2 mm. or more above the corneal one. After the suture is properly tied, the wound is firmly and usually permanently closed, thus giving valuable insurance against both iris prolapse and fistula, due to secondary opening of some portion of the wound. The value of firm wound closure with this suture in cases of accidental and unanticipated vitreous prolapse after delivery of the lens, as well as in the removal of primarily dislocated lenses, when, of course, vitreous presents with the section, is sufficiently obvious. In many cases there is an exceptionally small amount of (corneal) postoperative astigmatism, apparently because of the effect of the suture.

Regarding the section itself, it is of primary importance that its outer surface shall be throughout its entire extent in the conjunctiva, even though the conjunctival flap be ever so narrow. The reason for this we shall see later. The size of the section made with the knife is not of great importance, except that it must not be too large. Greater accuracy in placing the section in the proper plane, and in bringing the knife out at the correct distance from each arm of the suture, is secured with a small section than with a large one. A section that is too small is readily enlarged with one or more snips of a special curved scissor. Since lenses vary in size from case to case, and there are also other variable factors, one frequently does not know in advance just how large the section needs to be. In any case, the section should not be larger than is necessary.

Complications in wound healing, namely, corneal fistula and iris prolapse, may be due to traumatic factors, such as injudicious pressure on the eye at the first or later dressings, or violent behavior on the part of the patient, including vomiting, coughing, or sneezing. Much more often it is seen that iris prolapse, especially, is due to a faulty section, at least part of the outer surface of which lies well within the cornea itself. Wounds of the latter type, especially when their direction is almost or quite perpendicular to the surface, readily spring apart on the slightest provocation, as compared to those having even a narrow conjunctival margin. If one examines many cases of postoperative iris prolapse, regardless of whether the lens was extracted with or without iridectomy, it will be found that in a large proportion of cases, the prolapse is located in a part of the wound tract that is entirely within the cornea. This will not be prevented even by the corneoscleral suture, unless the corneal portion of the section is very small and the suture bridges the central portion of it. In short, wound healing is more rapid and more firm between conjunctival wound surfaces than between corneal wound surfaces.

These same considerations apply to the complication of corneal fistula, which is

simply a wound opening that for some mechanical reason cannot be plugged by the iris. If the plane of the wound tract is correct, the suture prevents many if not most traumatic influences from springing the wound open, and renders all ordinary movements of the head and body quite innocuous from the first postoperative day.

The question of the proper role for iridectomy in cataract surgery is one which is well worthy of discussion. Without doubt there are types of cases in which total iridectomy is necessary or desirable, and others requiring basal iridectomy after extraction of the lens through the pupil. Besides these, however, one sees patient after patient who has been subjected to total iridectomy without any real necessity or advantage. It is possible and entirely practicable to extract the lens without iridectomy of any kind, and without added risk, in a large proportion of patients up to the age of 75 years, by substituting for iridectomy a preliminary dilatation of the pupil. The choice of mydriatics and dosage for this purpose is a matter of individual judgment because the requirements vary so much from case to case. With insufficient dilatation the lens is held back, unless there are no definite sclerotic changes of the sphincter region, especially in the extracapsular operation, and the extraction becomes unduly difficult or impossible until a total iridectomy is done. On the other hand, with overdilatation the knife may wound the iris while making the section, and, furthermore, after the lens extraction the iris may persistently fall into the wound, so that it becomes difficult or impossible to tie the suture without incarcerating the iris in the wound. Such a contingency requires iridotomy or iridectomy, either basal or total. A pupil width of 5.5 to 6.5 mm. is desirable in most cases, but here, the larger pupil would be excessive in a young patient with a very resilient and elastic iris, while the smaller pupil would be insufficient in a very old patient with a very sclerotic iris. The most suitable dosage and combination of mydriatics can be determined by preliminary testing well in advance of the operation.

What, then are the conditions requiring total iridectomy? First, all cases in which preoperative examination shows too marked a sclerosis of the sphincter region of the iris. This is to be judged partly by slitlamp examination, but largely by the extent to which the pupil can be dilated, and will naturally occur chiefly in the aged. Second, when at the time of the operation it is found to be impossible to extract the lens through the pupil, a total iridectomy obviously must be done. Third, if the Verhoeff intracapsular method is used, total iridectomy must precede the extraction. Fourth, if the eye has persistently increased tension, that is, if some form of real glaucoma exists, then iridectomy must, as a rule, be done, and as a separate procedure at least a few weeks prior to lens extraction. Under most other circumstances, the so-called preliminary iridectomy is superfluous and scarcely more than the survival of an antiquated method.

Basal iridectomy is quite unnecessary as a routine in round-pupil extractions when the corneoscleral suture is employed. Since not every operation works out exactly according to plan, however, untoward conditions may occur which seem to require basal iridectomy, or at times even total iridectomy. Such conditions are principally the following: a faulty section, partly intracorneal; loss of the suture by accidental cutting or otherwise; persistent falling of the iris into the wound (prolapse) at the close of the operation, due to poor sphincter tone or overdilatation.

We are now ready to state the conditions under which iridectomy can with due safety be entirely omitted. These conditions are as follows: a section placed in its entirety in the correct plane; an iris which replaces itself spontaneously after the lens extraction, or which readily stays in position after replacement with the iris spatula; a firm and satisfactory closure of the wound with the corneoscleral suture.

The retention of an unduly large amount of lens cortex in the anterior and posterior chambers, especially in the latter, often gives rise to postoperative uveitis, followed by so-called secondary cataract, although either may occur without the other. A successful intracapsular extraction invariably, of course, prevents the second of these complications, and frequently the first as well. When the extracapsular method is used, capsulectomy with the toothed forceps and removal of the lens cortex, especially with the anterior-chamber irrigator, are indispensable for the prevention of these complications. The writer finds the Goldstein irrigator to be the most satisfactory type, and there is no need for undue timidity in its use.

Summary and conclusions

For securing the ideal result in cataract surgery, comprising maximal vision, preservation of the anatomical integrity of the eye as fully as possible, and for the prevention of several important complications, the following procedures have been found to be of great value: Ciliary-ganglion injection, corneoscleral suture, lens extraction without iridectomy, and, for the extracapsular technique, capsulectomy and adequate irrigation of the anterior chamber.

It has been observed that total iridectomy is practically a routine in cataract surgery with some operators, and is employed by many others with greater frequency than is necessary. It is believed that without firm closure of the wound, many patients are subjected to added risks of complications in wound healing that are in most cases eliminated by the corneoscleral suture. In a large proportion of cases, lens extraction can be safely accomplished without iridectomy, thus enhancing both visual and cosmetic results, by accurate preliminary dilatation of the pupil and by firm wound closure with the corneoscleral suture.

58 East Washington Street.

NOTES, CASES, INSTRUMENTS

METHOD OF PREPARING A TRANSPARENT EYEBALL*

H. ROMMEL HILDRETH, M.D.
Saint Louis

After seeing a transparent human skull at the Eye Institute of Columbia University, on a recent trip to New York, the writer became interested in learning the method of preparing such specimens. Many structures when prepared in this manner become invaluable for the teaching of anatomy. As early as in 1911, Spalteholtz described a method which has been used successfully for a number of tissues. It was difficult to find detailed information on the subject; no doubt because of the variety of tissues and organs that can be cleared. The size alone will alter the procedure to some extent. By experiments, however, it has been possible to adapt the method satisfactorily for different parts about the orbit.

The theory underlying the procedure is to remove opaque substances, such as dirt, pigment, and bone, and then place the tissue in a medium whose index of refraction is sufficiently close to that of the tissue so that the latter becomes partially transparent. The tissue is fixed, bleached, decalcified (if bone is present), dehydrated by the alcohol series, then placed in benzine, and finally in a mixture of oil of wintergreen and benzyl-benzoate.

Figure 1 is reproduced from a stereophotograph of a pigmented rabbit eye. The albino eye becomes so transparent that the uveal structures can hardly be seen; consequently, it is less interesting. The lens, of course, is seen better and it will fluoresce brilliantly in the presence of ultraviolet light.

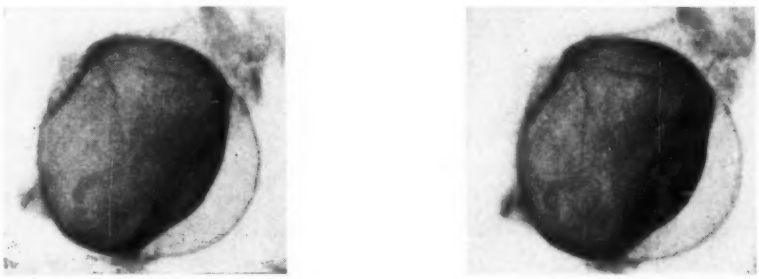

Fig. 1 (Hildreth). Stereophotograph of transparent eyeball.

The following procedure will be adequate for any size of eye up to that of the human globe: 1. Fix in 10-percent formalin for three days. 2. Wash in running water two days. 3. Bleach in 17-percent hydrogen peroxide for three days, changing once each day (for a lightly pigmented human eye two days are adequate, whereas four days would be best for a negroid eye). 4. Wash in running water one day. 5. Place in 50-percent alcohol three days. 6. Place in 70-percent alcohol three days. 7. Place in 80-percent alcohol three days. 8. Place in 95-percent alcohol three days. 9. Place in absolute alcohol for nine days, changing the alcohol every three days. (The eye must be thoroughly dehydrated and, of course, can be left in alcohol as long as desired.) 10. Place in benzine four days, changing

*From the Department of Ophthalmology, Washington University School of Medicine.

once after two days. 11. Place in a mixture of four parts of oil of wintergreen (methylsalicylate) and three parts of benzyl benzoate. The transparency will be complete after a few hours. If the specimen is to be kept in a jar with cemented top it is best to change after two days to a second oil-of-wintergreen benzyl-bonzoate mixture, for benzine attacks most glass cement and the change would remove most of the benzine. If there are any air bubbles in the specimen they may be removed before sealing, by placing the container in a vacuum. After a fair amount of vacuum has been attained so as to draw off the air in the oil, the bubbles will readily dissolve in the oil after the vacuum has been released.

Such a specimen is very striking and, of course, much more interesting than the illustration can indicate, even when viewed through a stereoscope. The various layers are easily recognized under the slitlamp microscope as well as by gross observation. At present the writer is preparing a series of animal eyes that should prove interesting from the standpoint of comparative anatomy.

Metropolitan Building.

VISION AND CENTRAL FIELDS AFTER GLAUCOMA OPERATION*

E. V. L. Brown, M.D.
Chicago

There is a general impression that vision is seldom improved by operation in simple glaucoma and that narrow fields may be abolished down to fixation. I cannot recall that I have ever known of such a case and for this reason I present a short series of cases which show that vision is frequently somewhat improved and that central fields are seldom abolished even when sight has been destroyed to within two to five degrees of the fixation point.

Case 1. Miss M. H., aged 32 years, had a scotoma to within 4 degrees of fixation. Intraocular tension was 32.5 mm. Hg (Schiötz), and vision 0.2 — 1. Seven months after the operation there was no scotoma within 10 degrees of fixation, the intraocular tension was 11.5 mm. Hg, and vision 0.3 — 1.

Case 2. Mrs. F. P. Z., aged 60 years, had a scotoma to within 3 degrees of fixation. The intraocular tension was 51.5 mm. Hg; vision 1 — 3. Six months after the operation there was no scotoma within 3 degrees of fixation, her intraocular tension was normal, and vision was 0.6 + 1.

Case 3. Robert S., aged 66 years, had a scotoma to within 2 degrees of fixation. The intraocular tension was 22.5 mm. Hg; vision 1 — 4. Three weeks after operation the scotoma remained unchanged, the intraocular tension was 18 mm. Hg, and vision 0.8 — 3.

Case 4. Reuben M., aged 68 years, had a scotoma to within 5 degrees of fixation. The intraocular tension was 64 mm. Hg, and vision was restricted to the ability to see hand movements. Six months after the operation there was no scotoma within 15 degrees of fixation, the intraocular tension was 14 mm. Hg, and vision was 0.2.

Case 5. Miss L. M., aged 57 years, had a scotoma to within 1 degree of fixation. The intraocular tension was 44 mm. Hg, and vision 0.8 — 3. Five years after the operation the scotoma remained the same, the intraocular tension was 14.5 mm. Hg, and vision 0.3.

Case 6. Edward B., aged 69 years, had a scotoma to within 2 degrees of fixation. The intraocular tension was 24

* Read before the Chicago Ophthalmological Society May 24, 1937.

mm. Hg, and vision 0.2 + 1. Twelve months after the operation the scotoma had advanced to within 1 degree of fixation, the intraocular tension was 10 mm. Hg, and vision 0.8.

Case 7. John D., aged 59 years, had in the right eye a scotoma that extended for five or more degrees beyond fixation on all sides. The intraocular tension was 56 mm. Hg, and vision 0.1. Fourteen months after the operation there was no scotoma in the central field whatever. The intraocular tension was 24 mm. Hg, and vision 0.6 + 2.

In the left eye a scotoma extended for five or more degrees beyond fixation on all sides; the intraocular tension was 33 mm. Hg, and vision 0.2 — 1. Fourteen months after the operation there was no scotoma whatever in the central field, the intraocular tension was 24 mm. Hg, and vision 0.6 — 2.

Case 8. Mrs. F. D., aged 74 years, had a scotoma to within 1 degree of fixation, an intraocular tension of 30.5 mm. Hg, and vision was 0.3. Two months after the operation there was no scotoma within 3 degrees of fixation, the intraocular tension was 15 mm. Hg, and vision 0.4.

Case 9. W. M. K., aged 39 years, was found to have a form field that was almost normal; an intraocular tension of 47 mm. Hg, and vision was 0.1.

Seven-and-one-half years after the operation the visual fields were not taken; the intraocular tension was 20.5 mm. Hg, and vision 0.4 + 1.

OPERATIVE RESULTS IN 10 GLAUCOMATOUS EYES WITH "DANGEROUSLY POOR" CENTRAL FIELDS OR CENTRAL VISION

Case	Vision		Fields		Tension		Observation
	Before Op.	After	Before Op.	After	Before Op.	After	After Op.
1	0.2−1	0.3−1	4	10	32.5	11.5	7 months
2	1.0−3	0.6+1	3	3	51.5	normal	6 months
3	1.0−4	0.8−3	2	2	22.5	18	1 month
4	H.M.*	0.2	5	15	64	14	6 months
5	0.8−3	0.3	1	1	44	14.5	60 months
6	0.2+1	0.8	2	1	24	10	12 months
7 RE	0.1	0.6+2	0	20	56	24	14 months
LE	0.2−1	0.6−2	0	20	33	24	14 months
8	0.3	0.4	1	3	30.5	15	2 months
9	0.1	0.4+1	almost normal	not taken	47	20.5	90 months

* H.M. = ability to see hand movements.

The data from these nine cases are collected in the accompanying table.

The ten eyes show an average increase of one line in vision, almost 6 degrees regression of the scotoma from the fixation point, and a reduction of 22 points in the increased tension. The average period of observation after operation was 23 months.

122 South Michigan Avenue.

SOCIETY PROCEEDINGS

Edited by Dr. H. Rommel Hildreth

CHICAGO OPHTHALMOLOGICAL SOCIETY

February 15, 1937

Dr. G. Henry Mundt, *president*

Obstetrical ophthalmology

Dr. Dewey Katz read a paper on this subject.

Kodachrome clinic

Dr. Robert von der Heydt demonstrated clinical cases of anterior-eye and fundus pathology with lantern slides of Kodachrome photographs.

Visual acuity survey

Dr. Clarence W. Rainey read a paper on this subject which was published in this Journal (August, 1937).

Discussion. Dr. Leo L. Mayer said that Dr. Rainey has made a really valuable contribution by showing what can be done by a visual survey in industry. The literature does not contain many such surveys. Dr. Rainey spoke of taking color vision in each eye separately, and it would be interesting to know if he found any difference in the two eyes. Also, did he find any difference in atropine and homatropine refractions?

Dr. Thomas D. Allen said that by reason of the Social Security Act, unquestionably the ophthalmologist will be called upon more and more to make visual surveys. The employer will need to know how many of his employees have reduced vision, so that he will not be held responsible for reduced vision if present before they are employed. Dr. Rainey has made a good start in this direction. If more of the members have such opportunities, it is hoped that they will handle it in as thorough a manner, and report it to the Society so that we may be helped in our general attitude toward employers and employees.

Dr. Louis Bothman spoke of Dr. Rainey's remark that he had not seen any glaucoma develop following the use of homatropine. He himself had used homatropine, scopolamine, and atropine in the clinic and in his office for years, and had yet to see a single case in which the tension, normal before the use of a cycloplegic, could not be brought back to normal with miotics dropped upon the conjunctiva or by baths with an eye cup. A patient who has glaucoma, of course, should never have a cycloplegic.

Dr. Clarence W. Rainey (closing) in reply to Dr. Mayer's question said that according to Fuchs, congenital color blindness is occasionally unilateral. A few such cases were found in this survey, but oftener the difference in the color vision of the two eyes was due to some pathological condition.

Robert von der Heydt.

COLLEGE OF PHYSICIANS OF PHILADELPHIA

Section on ophthalmology

February 18, 1937

Dr. Charles R. Heed, *chairman*

Developmental and anatomical factors in dacryocystitis

Dr. J. Parsons Schaeffer said that the origin and development of the efferent lacrimal passageways not only clarify the general plan of the anatomy but the anatomic types and anomalies as well. From the deep layer of the ectoderm along the line of the obliterated naso-optic groove grows a solid strand or cord of epithelial cells, the rudiment or anlage of the nasolacrimal passageways. This cord of epi-

thelial cells becomes detached from the surface and surrounded by mesenchymal cells. Sprouting occurs at both the nasal and ocular ends, thereby connecting the solid epithelial cord with the free borders of the eyelids and the mucous membrane of the inferior nasal meatus.

A lumen forms within the solid cord which begins at the ocular end of the parent cord and progresses toward the nasal end, being well advanced in embryos of 100 days. The horizontal portions of the lacrimal ducts or canaliculi become canalized before the vertical portions. Canalization of the areas of union between the free borders of the eyelids and the lacrimal ducts is often deferred until a later period and occasionally does not take place at all, variously resulting in atresias at these points. Frequently at birth, the lacrimonasal membrane between the nasal end of the nasolacrimal duct and the inferior nasal meatus remains unruptured, thus giving rise to an atresia at the usual point of outlet. The membrane may become sufficiently attenuated during the first months of infancy to rupture spontaneously. If the aperture does not become established operative interference is required.

Normally canalization of the solid nasolacrimal rudiment occurs very irregularly, and at an early time there is abundant evidence of mucosal ledges, valves, and diverticula. Secondary buds from the stem rudiment account for the larger diverticula that are encountered in later life. The belief that these diverticula are acquired in adult life as the result of disease is not justified. They have an embryonic origin.

From the genetic point of view, the variations in the anatomy of the adult nasolacrimal passageways fall into three important categories or groups; first, those that have their origin in rudiment potentials; second, those due to early arrests in the development of parts that should proceed from the stem rudiment; and third, those due to division of previously continuous ducts into discontinuous segments, the latter probably caused by anatomic bands. Rudiment potentials explain such variations and abnormalities as supernumerary lacrimal ducts for one or both eyelids; duplication and triplication of the lacrimal puncta, the solid and furrowlike lacrimal punctum; mucosal ledges and so-called valves within the nasolacrimal duct, irregularities of contour and diverticula; variation in the anatomy of the lacrimonasal aperture in the inferior nasal meatus; osseous and membranous segments of the main nasolacrimal ducts. Developmental arrests lead to other abnormalities.

The plane of direction of the osseous nasolacrimal canal conforms to the type of facial skeleton. The breadth of the bridge of the nose, the width of the inferior nasal meatus, and the degree of expansion of the piriform aperture influence the course or direction of the osseous nasolacrimal canal. Generally speaking, one may say that the osseous nasolacrimal canal is projected caudalward, lateralward, and dorsalward along a plane erected from the lacrimal fossa to the interval between the second premolar and the first molar, the first and second molars, or even as far dorsalward as the interval between the second and third molar teeth. The almost vertical plane frequently shown in textbooks is erroneous.

An important anatomic feature of the mucous membrane of the lacrimal sac is the presence beneath the epithelium of a relatively thick fibroelastic tunica propria with an abundance of lymphoid tissue, some of which is arranged in definite masses not unlike the aggregated nodules of the small intestine. Small tubular glands are found, and frequently numerous cells exhibit stages of conversion into mucus-containing goblet cells. Another

anatomic feature is the loose tissue which connects the tunica propria with the periosteum. This tissue everywhere is occupied by a rich plexus of veins that partakes of the nature of a modified erectile tissue. The blood spaces, which are under autonomic control, are large and the stratum containing them is subject to very rapid engorgement and depletion. The extensive venous plexus of the nasolacrimal sac and the nasolacrimal duct is believed to be a factor in the flow of tears from the conjunctival cul-de-sac to the inferior nasal meatus.

As early as in the eighteenth month of infancy the nasolacrimal duct bears an intimate relationship to the maxillary sinus. The ethmoidal cells that develop from the frontal recess and from the ethmoidal infundibulum are nearest the lacrimal sac at birth. The topographic relationship is, however, not intimate at this time. By the fifth or eighth year the anatomic relationships between the paranasal sinuses and the lacrimal fossa are, in essence, those of the adult. In the latter, the frontal and maxillary sinuses and the anterior group of ethmoidal cells need to be considered in this connection, and of these the anterior ethmoidal cells are of special importance. Indeed, at times the walls of the lacrimal fossa and the upper part of the osseous nasolacrimal canal are pneumatized by ethmoidal cells, variously related to the lacrimal sac and the upper part of the membranous nasolacrimal duct.

From a clinical point of view the lacrimonasal aperture or ostium in the inferior nasal meatus may be divided into five types: (1) those that fail of canalization, that is the lacrimonasal membrane remains intact; (2) those of microscopic size and wholly inadequate for the function intended; (3) those located at the highest point of the inferior nasal meatus with osseous walls, wide-mouthed, permanently open, and unguarded by any valvelike fold of mucous membrane; (4) those located in the mucous membrane of the lateral wall of the inferior nasal meatus some distance below the attached border of the inferior nasal concha and frequently guarded by a valvelike structure of mucous membrane; (5) those located in the mucous membrane of the lateral wall of the inferior nasal meatus without an adequate valve from the point of view of physiology. The anatomic type of lacrimonasal aperture is undoubtedly a factor in satisfactory drainage of tears into the inferior nasal meatus and a regurgitant infection of the lacrimal sac in nose blowing.

The origin and development of the efferent lacrimal passageways point the way to a better understanding of the congenital variations and defects. A knowledge of the developmental history and potentialities is a definite aid in deciding upon the course of treatment of the several types of congenitally atypical ducts. The important anatomic types of departures from the so-called typical have a bearing in disease, prognosis, and treatment. Although in many nasolacrimal ducts the lacrimal probe can be successfully passed, there are anatomic types in which probing cannot be performed with any degree of success, and much injury may result. In the latter cases conservative treatment would be much more effective than probing.

It is to be hoped that roentgenographic study will be extended to include the lacrimal passageways in the living body in order that the rhinologist may gain some knowledge of the anatomic character of the nasolacrimal passageways which he is about to treat.

Dacryocystorhinostomy

Dr. Alvin Howland presented a survey of a large number of surgical cases in which treatment was by external dac-

ryocystorhinostomy. The results obtained were compared with a similar number of cases treated by the ordinary removal of the lacrimal sac. This article will be published in the Archives of Ophthalmology.

Discussion. Dr. Edmund B. Spaeth said that there are some points that must be emphasized in Dr. Howland's paper, relative to indications and contraindications and causes of failures. Too large an osteotomy will close in so that the retained portion of the sac will be too small to permit bridging of the bony opening. In such instances, healing cannot occur between the nasal mucosa and the periosteum at the edges of the osteotomy with the edges of the retained portion of the sac. Tearing the internal common punctum while probing during the operation is a cause of failure. Too extensive a resection of the sac wall itself is also a cause of failure. If the resection of the sac wall is greater than it should be, the sutures, which must be inserted from the periosteal edges of the osteotomy to the sac margin itself, will drag the sac out of the osteotomy opening as a taut diaphragm. The bony opening will then close beneath this, and as a result one has neither a dacryocystorhinostomy nor a dacryocystectomy. Failure to resect the bone to a proper level will permit a lake of pus to remain undrained at the superior extremity of the bony lacrimal nasal duct. The anatomy of the bony fossa varies to a great degree and the bone resection must be equal to the lowest level of the sac regardless of whether one is working with the lacrimal bone or at the lacrimal crest of the malar. Adequate postoperative intranasal attention is necessary; that is, the nose must be kept free of clots and crusts by irrigation through the punctum and by the use of a combination of liquid petrolatum and ephedrine.

Chronic ethmoiditis is not necessarily a contraindication unless polypi are present. If so, these must be removed first. The same thing applies to an enlarged tip of the middle turbinate. If it will not shrink out of the way then a partial turbinectomy must be done. Traumatic obstructive dacryocystitis responds well to a dacryocystorhinostomy, though there is no doubt that in the chronic suppurative cases with a large dilated cystocele the operation is easier of accomplishment. Intraocular surgery can be performed without fear of complications after a successful dacryocystorhinostomy. Fistulae, when present, heal spontaneously and promptly after a rhinostomy. Chronic atrophic rhinitis is a rather definite contraindication. Osteomyelitis, if present, is rather likely to be tuberculous. This is a contraindication. A dacryocystorhinostomy, in the presence of slit canaliculi, will not correct the epiphora. If these cannot be bridged over by the repeated application of cautery then one should proceed with a cystectomy.

Occasionally during the surgery one may open into an anterior ethmoidal cell. The osteotomy should be continued as if this complication had not occurred. It is wise, however, to curette the anterior ethmoidal cells that were opened so that the osteotomy will not close as a result of suppuration from the ethmoid. This has happened several times and in each instance the patient was referred to a rhinologist for subsequent treatment of the ethmoids. There were no failures as a result of this complication.

Dr. Francis Heed Adler asked whether there is any danger in accidentally perforating an anterior ethmoidal air cell by making the window in the bone too high up.

The most frequent objection that is heard against this operation is that it is not suitable for a patient on whom a cataract operation is contemplated, on the ground that infection can spread directly from the nose into the conjunctival cul-

de-sac. The advocates of the operation maintain that there is no more danger of infection than after dycryocystectomy. They reason, and perhaps rightly so, that the flow of tears into the nose prevents ascending infection, whereas in the old operation of dacryocystectomy, bacteria were able to multiply in the conjunctival cul-de-sac due to stagnation of the lacrimal fluid. It would be interesting to compare cultures from the conjunctival cul-de-sac of a series of patients in whom a dacryocystectomy had been done on one side, and a dacryocystorhinostomy had been done on the other. He believed this would give a truthful answer to the question.

Dr. Howland said, in conclusion, that in his cases he had seen one with the ethmoid cells exposed. The periosteum would act as a protection in case any of them should be exposed on account of the elevation, and they would then fall back into place. On several of the patients in this series cataract extractions were later performed. All showed an uneventful recovery.

Congenital imperforations of the nasolacrimal duct

Dr. William Zentmayer said that the term dacryocystitis is inappropriate. Failure of absorption of the epithelial cord with imperforation at the meatial opening is the most common cause. The two principal complications are infection of the epithelial contents of the sac, producing true dacryocystitis; and, at times, abscess. The prognosis is good if the obstruction is removed early.

Probing is strongly urged to prevent infection and abscess and the possibility of infection in case corneal injury or ulcer develops; also because of the satisfaction of the parents in having the blemish removed.

In only two instances in the author's experience was more than one probing required. The procedure can be carried out without general anesthesia as the probe meets with no firm obstruction in its passage.

A. G. Fewell,
Clerk.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Section on ophthalmology

February 9, 1937

Dr. W. L. Benedict, *president*

Tuberculosis of the anterior uvea

Dr. C. S. O'Brien (Iowa City) said that uveal tuberculosis is rather common, and must always be considered as a possibility in chronic iridocyclitis. The ocular changes usually occur in juveniles or adults who are otherwise apparently well. The iridocyclitis is secondary to an old arrested focus in the chest cavity. Diagnosis is difficult since the clinical picture varies and absolute proof of old primary lesions in the chest may be lacking. Tuberculosis should be suspected as a cause in chronic types of iridocyclitis in which the onset has been insiduous, there is little or no pain, the eye is only slightly congested, relapses occur, and response to ordinary treatment is slow or absent. Proof of a primary lesion rests on the history, physical examination, roentgenograms, and response to diagnostic injections of tuberculin.

Clinically, tuberculosis of the iris may be of a diffuse or nodular type. The diffuse type is more common, and typically there is a low-grade, chronic, plastic inflammation showing large, lardaceous deposits on Descemet's membrane, a few cells in the aqueous, a tendency to posterior synechiae, Gilbert-Koeppe nodules

at the pupillary margin of the iris, and eventually a cyclitic glaucoma. In the less common, nodular type of iris inflammation there are large mutton-fat deposits on Descemet's membrane, Gilbert-Koeppe nodules at the pupillary margin, and translucent gray nodules are present in the iris. Posterior synechiae are rare, and secondary glaucoma is infrequent.

There is a wide variation in the pathologic picture, due to the influence of allergy, immunity, and perhaps other factors. There may be a diffuse infiltration of the iris and ciliary body with lymphocytes and plasma cells producing the nonspecific type of inflammation described by Poncet, or the lesion may be typically tuberculous; that is, presenting areas of epithelioid cells surrounded by lymphocytes and plasma cells, with giant cells here and there. Caseation does not occur.

Syphilitic iridocyclitis, sympathetic uveitis, lesions resulting from focal infections, and other unusual pathologic conditions must be differentiated.

Treatment is similar to that employed in tuberculosis in other parts of the body; that is, the removal of foci of infection, rest, sunshine, and nourishing foods. In addition, tuberculin therapy is indicated.

Discussion. Dr. Walter Fink (Minneapolis) said that in practice he has encountered cases in which there was evidence of an ocular irritation, but the slit-lamp findings were entirely negative except for cells in the retrolental space. Is it possible that a low-grade cyclitis of a tuberculous nature would be manifested in this way? He also asked whether or not Gilbert-Koeppe nodules are occasionally found in senile cases in which there is an advanced vascular degeneration.

Dr. C. N. Spratt (Minneapolis) said he would like to ask Dr. O'Brien if he thought one should put much reliance in X-ray films of the chest in these cases of tuberculosis of the eye. It is generally recognized that a large proportion of adults show changes in the lung. This varies of course in different countries and is more prevalent in the city than in rural areas. Some German statistics give pulmonary changes, as shown by X ray, in 90 percent of the cases. It would seem that the only positive diagnosis in tuberculosis of the eye would be by the use of tuberculin, and the eye would show a focal reaction. Nearly 30 years ago Stock injected the ear vein of rabbits with tuberculin bacilli and found that they developed a mild uveitis and scleritis in which there was round-cell infiltration. Practically none of these lesions showed caseation.

Dr. O'Brien said, with regard to the deposits in the retrolental space, that the diagnosis of tuberculosis is very difficult, and he hoped the members did not feel he represented himself as thinking that the diagnosis of tuberculosis of the eye is easy. In his opinion one would not be logical, if deposits were found only in the retrolental space, in saying that the patient had tuberculosis. And if, on the administration of fresh purified tuberculin, an increase in these deposits were seen, one would not be justified in calling it tuberculosis. Probably it would be more justifiable to call it cyclitis. The question of the etiologic agent would be difficult to determine, but one should think of tuberculosis. The diagnosis should rest on further tests and more information.

As to the Gilbert-Koeppe nodules, they are of fibrin, and are gelatinous, semi-opaque, inflammatory masses. Dr. O'Brien said he had not seen any deposits in advanced vascular disease that are analogous to the Gilbert-Koeppe nodules; he had seen them only in cases in which he believed tuberculosis was present. As far as vascular disease is concerned, he did not know of any reason why they should be there in degenerative disease. There are pigmented nodules with cystic

degeneration that are herditary in character, but they cannot be confused with nodules of fibrin.

Dr. O'Brien said he was sorry if he had given the impression that he placed too much emphasis on the X ray. He does not feel at all that the X ray clinches the diagnosis of tuberculosis; but he would hesitate very much to make a diagnosis of tuberculosis, no matter what the appearance of the eye might be, without positive findings in the X-ray film. It is well known that reports from European clinics indicate that 90 percent of the people have had tuberculosis and have arrested pulmonary lesions; also a great many people will give positive tuberculin reaction. He did not mean to say that every inflammation and every patient who has a positive tuberculin reaction has a tuberculous uveitis. He emphasized the X-ray examination only as an added means to diagnosis. In other words, if he suspected the presence of a tuberculous uveitis and could not find evidence of tuberculosis elsewhere, and perhaps in the face of a negative tuberculin reaction, he would hesitate very much to make a diagnosis of tuberculous uveitis. He said he was quite sure that there is more tuberculosis in Vienna than is found in agricultural communities, such as he has worked in. By no means has that proportion of the population had tuberculosis, according to the X-ray and general findings.

Walter E. Camp,
Secretary.

AMERICAN JOURNAL OF OPHTHALMOLOGY

Published Monthly by the Ophthalmic Publishing Company

EDITORIAL STAFF

LAWRENCE T. POST, *Editor*
640 S. Kingshighway, Saint Louis

WILLIAM H. CRISP, *Consulting Editor*
530 Metropolitan Building, Denver

EDWARD JACKSON, *Consulting Editor*
Republic Building, Denver

HANS BARKAN
Stanford University Hospital, San Francisco

HARRY S. GRADLE
58 East Washington Street, Chicago

H. ROMMEL HILDRETH
824 Metropolitan Building, Saint Louis

PARK LEWIS
454 Franklin Building, Buffalo

C. S. O'BRIEN
The State University of Iowa, College of Medicine, Iowa City

M. URIBE TRONCOSO
500 West End Avenue, New York

JOHN M. WHEELER
635 West 165th Street, New York

EMMA S. BUSS, *Manuscript Editor*
4907 Maryland Avenue, Saint Louis

Directors: EDWARD JACKSON, President, LAWRENCE T. POST, Vice-President, DR. F. E. WOODRUFF, Secretary and Treasurer, WILLIAM L. BENEDICT, WILLIAM H. CRISP, HARRY S. GRADLE.

Address original papers, other scientific communications including correspondence, also books for review and reports of society proceedings to *Dr. Lawrence T. Post, 640 S. Kingshighway, Saint Louis.*

Exchange copies of medical journals should be sent to *Dr. William H. Crisp, 530 Metropolitan Building, Denver.*

Subscriptions, applications for single copies, notices of change of address, and communications with reference to advertising should be addressed to the *Manager of Subscriptions and Advertising, 640 S. Kingshighway, Saint Louis.* Copy of advertisements must be sent to the manager by the fifteenth of the month preceding its appearance.

Author's proofs should be corrected and returned within forty-eight hours to the *manuscript editor.* Twenty-five reprints of each article will be supplied to the author without charge. Additional reprints may be obtained from the printer, the George Banta Publishing Company, 450-458 Ahnaip Street, Menasha, Wisconsin, if ordered at the time proofs are returned. But reprints to contain colored plates must be ordered when the article is accepted.

THE "READER'S DIGEST" ARTICLES ON OPTOMETRY

Probably no public airing of the points at issue between oculists and optometrists has been so effective as that occasioned by the Riis article in the August issue of the Reader's Digest. To any strictly impartial expert observer the August article had the appearance of being colored a little too exclusively by the conventional attitude of ophthalmic surgeons; whereas Riis's September article in the Digest, in spite of the author's air of balanced judgment, suggested a desire to pacify the opposition by leaning in the contrary direction.

The dominant facts brought out by Riis (as they might impress the layman) seem to be as follows:

(1) Ophthalmologists, ophthalmic physicians, or oculists—in other words, the physicians and surgeons who devote their time to the care of ocular conditions, including refractive errors—are not sufficiently numerous to accommodate the very large group of patients requiring ocular care.

(2) The title "optometrist" has come to be applied to a body of men and women without medical training but who have established a legal right to represent themselves as especially qualified in refraction, and who actually make refractive measurements upon the basis of which they furnish glasses to the major part of the population of the United States.

(3) Somewhere in the neighborhood of ninety percent (as suggested by Riis's figures) of optometrists are purely commercial rather than professional, live by

the sale of spectacles and not by the receipt of professional fees, and are more or less grossly incompetent to measure refractive errors or to warn the patient of the existence of ocular disease or of general disease of which ocular symptoms may be the expression.

The problem is neither new nor simple of solution. Many ophthalmologists refuse to recognize the optometrist as having a professional place in the community. To these ophthalmologists the optometrist, so far as he has any standing whatever, is and should remain merely an optician who makes and sells glasses which have been prescribed by an ophthalmologist.

There is a small group of optometrists (estimated at ten percent by Riis in his September reply to the praise and blame of his critics) who are able, conscientious, and professional rather than commercial in their point of view. But the inefficient body of purely commercial optometrists (as distinguished from the artisan who is frankly an optician in the old sense of that word) dominate the conditions under which optometric practice is carried on, and stand in the way of strictly professional requirements for optometrists.

Does the medical profession expect ever to be able to care for the refractive needs of the whole population? There is some ground for believing that this could only be accomplished by at least doubling the present number of ophthalmologists, or by teaching general practitioners to undertake this work. Does the medical profession believe that it can abolish the practice of optometry as the best optometrists understand it? Who then would supply the needs of the public? If optometry must continue to exist, what is to prevent its acquiring an increasingly professional status? Ought optometrists to possess a sufficient degree of medical knowledge to enable them to recognize the existence of ocular disease in their patients or customers, even if for no other purpose than sending these patients to a specially qualified medical practitioner? And if the optometrist ought to acquire an intelligent understanding of diseases of the eye, who but the ophthalmologist is well qualified to give him that understanding? Then is it necessarily unethical for an ophthalmologist to give instruction to, or to consult with, optometrists, as was declared in 1935 by the Section on Ophthalmology of the American Medical Association?

The sheer statistics of the problem should impress us. If Mr. Riis's figures are authentic, the American public spends some $75,000,000 a year for spectacles. There are a great many more optometrists than oculists. The optometrists claim that they prescribe three fourths of the glasses used in the United States. Yet under state optometry laws only eight American schools of optometry are recognized as adequate, and these schools have been turning out only about three hundred graduates annually. Of the schools whose graduates are qualified to take the state license examinations, only three are affiliated with recognized universities, and graduates of these three schools alone are eligible for examination in the state of New York. Several thousand optometrists have been so anxious to use the title of "doctor" that they have paid fifty dollars each to a correspondence school and diploma mill for a ninety-day course leading to the degree of "doctor of optometry," although none of the optometry schools affiliated with universities confers such a degree, and some states specifically forbid the use of the title "doctor" by optometrists.

The profession of optometry had its legal birth thirty-six years ago. It seems a long time coming to maturity.

The secretary of the American Academy of Optometry, as quoted by Riis, frankly recognizes that storekeeping (and the great majority of optometrists are storekeepers) is not a good basis for persuading legislators and the courts that optometry is a profession. The American Optometric Association, we are also told, has gone on record in favor of "the divorcement of the practice of optometry from any business," and for the removal of all semblance of commercialism from optometrists' places of practice. Yet Riis is able to quote from the Journal of the New York State Optometric Association a frankly commercial pronouncement by the director of the American Optometric Association's department of public information. Riis says: "It is significant that optometrists advertising for positions in a trade magazine repeatedly include the phrase 'expert salesman' in their list of qualifications."

As our colleague Lancaster has intimated, there is room and need in the community for both optometrist and eye physician. When in 1913 the present writer ventured to draw a parallel between dentistry and optometry, the record of the medical profession was far from perfect as to quality of refraction work. There is still room for improvement as to the standards of such work among ophthalmologists; but there has been a tremendous advance in this regard since 1913. The progress of optometry toward professional status in the past twenty-four years has hardly been gratifying, except perhaps to its bitter enemies. State optometric associations and licensing bodies should awake to the fact that they must segregate commercial from professional "optometry."

The action of the Reader's Digest in publishing the articles on optometry in its August, September, and October issues has rendered a substantial public service. The results of these articles are likely to accrue in some degree in favor of the medical specialty of ophthalmology; in much greater degree to those optometrists and optometric organizations who can be made to see the light; and above all to the great American public.

In conclusion it may be said that the use of the title "optometrist," with its boastful misapplication and its vagueness of meaning in the minds of the laity, has added nothing to the general public convenience, nor has it advanced the professional status of a group of workers who would still be more satisfactorily described by the old title of "refracting opticians."

W. H. Crisp.

AN EIGHT-MONTHS' GRADUATE COURSE

Perhaps the best preparation for the practice of ophthalmology is a sound medical education followed by an internship in medicine or surgery in a representative institution where carefully supervised work is done, and thereafter an internship of not less than two years in a department of ophthalmology in which adequate systematic instruction is given.

It is not now possible to provide this for even half of those who wish to enter ophthalmology, and it does not seem probable that it will be possible to provide it for all for many years.

It is not in the nature of our specialty that more than a small percentage of patients should need hospital care. At least fifty percent and probably nearer seventy-five percent of the practice is refraction, leaving less than one third or perhaps even only a quarter of the cases as potentially hospital material. As a matter of fact, less than five percent of new patients in a clinic require hospitalization. Hence

there is no need for a great number of ophthalmic interns. Further difficulties are that there are not enough opportunities in the eye service in strictly private hospitals to render a two-year service of value in these institutions. Perhaps of even more importance is the fact that it is not feasible to offer systematic instruction to one or two men. The visiting staff can scarcely be expected to give up the necessary time for teaching individuals.

The question then arises as to what type of training it is possible to provide for the men unable to obtain ophthalmic internships. At present the only answer seems to be postgraduate courses. The eight-months' course has been selected because it conveniently occupies the academic year.

The objections to such a course are obvious. In the first place, it is insufficient; and in the second place, it is too didactic and provides too few contacts with patients. To justify its existence it is labeled "basic," and it is suggested that it be used as a preliminary to an internship; but it is not truly basic, and many of those who take the courses never get internships. Regarding the basic nature of the course, there are, in fact, a few subjects that might legitimately be placed in this category, but for the most part the training is clinical.

Because of the high fees necessary for conducting such courses as well as of the need to pay board and lodging, only those who have set aside at least fifteen hundred dollars can afford to pursue them. Hence, most applicants for the postgraduate courses will be in their late thirties or early forties. Fortunately, the younger men who have had a high standing in medical school will usually be successful in obtaining internships in ophthalmology.

It would seem as if no excuse were necessary for undertaking the training of these men of early middle life who for one reason or another at that time desire to specialize. In many ways the clinical experience they have had will be of real service to them, and if it is possible to offer them a course that will prove a fairly adequate introduction into the practice of the specialty, to do so is a laudable proceeding. Naturally the crux of the matter lies in the adequacy of the course. Theorizing will not entirely answer this question. One institution has offered a course with this objective for more than ten years and has been reasonably well pleased with the results, but this course is of necessity largely didactic because of the considerable number of men enrolled, which does not permit much contact with the patient. A more extensive clinical training would be more desirable, but this can be given to only relatively few. Another institution is trying out this year for the first time an eight-months' course for a few men, dividing it into approximately 500 hours of teaching and laboratory and 1200 hours of clinical practice under careful supervision. Disadvantages are the necessary cramming and the absence of practical surgical training, the only actual surgical experience being on cadavers and enucleated pigs' eyes. In a few years sufficient knowledge will have been acquired to help evaluate these eight-months' courses.

Perhaps to offer these manifestly incomplete courses and to turn out half-educated ophthalmologists is not a legitimate procedure; but, on the other hand, many of the men who take these eight-month's courses in lieu of something better would surely start out with even less training if this much were not offered. Possibly half a loaf is better than no bread.

Lawrence T. Post.

BOOK NOTICES

AUGE, part 3, vol. XI of HANDBUCH DER SPEZIELLEN PATHOLOGISCHEN ANATOMIE UND HISTOLOGIE. Edited by O. Lubarsch and F. Henke, 653 pages. Berlin, Julius Springer, 1937. Price $48.00.

This concluding work on the pathology of the eye, as a part of the most important encyclopedic work on the pathology of the entire body, includes the lens, the sclera, injuries of the visual organ, and the eyeball as a whole.

Division 12, on the lens, by A. v. Szily of Münster, occupies 282 pages and includes 213 illustrations. Very few of the latter are in color, in striking contrast to the first part of the pathology of the eye, published in 1928, and to the division on the lens by Adolph Jess in the Kurzes Handbuch der Ophthalmologie, volume 5, published in 1930. Twenty pages are used in describing the detailed changes in senile cataract—a valuable addition to our knowledge of lens changes. The pathology of over-ripening, morgagnian cataract, and black cataract is carefully reviewed. Under punctate cataract are included with reason coronary, cerulean, and green cataract. The nuclear or central and the lamellar cataracts are very capably considered from a broad standpoint. Results in the adult lens of the absence of an embryonic (Mann) nucleus is clearly described and illustrated for the first time. The capsular cataract derived from the anterior epithelium is treated at some length but is judged, as previously, to be a pseudometaplasia and not true connective tissue. An important contribution is a description of the effects on the lens of contusion. Dislocation of the lens, congenital, spontaneous, and traumatic, is fully reviewed over some 20 pages. Aseptic and septic wounds of the lens both in man and experimental animals afford a valuable comparison. Clinical and experimental findings in siderosis and chalcosis of the lens are described with care. Under the cataract due to endocrine disorders are included the diabetic, that of tetany, both clinical and experimental, and that of myotonic dystrophy. Lastly the glass-blowers' cataract, the action of ultraviolet and infrared rays on animal lenses, the action of Röntgen and radium rays on the lens of man and animals are discussed in valuable detail. Very timely also is the review on cataract due to electricity, both clinical and experimental in scope. References to the literature fill 40 pages. The assembly of the latter would alone make the work noteworthy and of great value for reference. The author is too prone, however, to let the quotations from the literature speak for themselves. More of the distinguished essayist's own opinions would have made the work more valuable. Nevertheless it is by far the most complete work on the lens in existence.

Division 13, on the sclera, by K. Oberhoff of Munich, occupies 40 pages and includes 19 illustrations and 3½ pages of references. This is also much the most extensive compendium on disorders of the sclera in the literature. There are described congenital melanosis of the sclera, congenital and traumatic cysts, scleral rupture, and staphyloma. Under scleritis, the progressive scleroperikeratitis is thoroughly reviewed over 10 pages, and tuberculosis of the sclera in four pages. Numerous other conditions are briefly mentioned.

Division 14, on injuries of the visual organ, by Erich Lobeck of Jena, occupies 170 pages and includes 78 illustrations, many in colors. In this work, the author states in the preface that he purposes to review the pathologic anatomy of

those injuries that directly or indirectly affect the eyeball as a whole. He divides the entire work into four subdivisions: I. Injuries from blunt blows. II. Injuries through sharp objects (including puncture, incised and shot wounds). III. Injuries through physical energy or rays. IV. Injuries through chemicals. Many excellent illustrations, including numerous photomicrographs, distinguish this work. The subject matter is systematically arranged for ready reference. Descriptions are brief and to the point. Facts regarding injuries of the eye are always valuable although necessarily many are repetitions of previous works on the subject.

Division 15, the eyeball as a whole, by K. Wessely of Munich, includes 80 pages and 69 illustrations, 15 in color. Here are depicted those changes of the entire eyeball which arise during life as the result of peculiarities of its structure. "In no other branch of ocular pathology does the transition from physiology to pathology proceed so smoothly as here." Accordingly, there is first discussed the architecture of the eyeball as a whole in the adult and the newborn, then the physiologic growth of the eye, the growth-correlation, and the pathologic growth. The myopic changes in the eye are thoroughly reviewed through some 60 pages. Lastly changes in the eye from hyperopia and age are described.

Harvey D. Lamb.

THE SCIENCE OF SEEING. By Matthew Luckiesh and Frank K. Moss. Clothbound, 558 pages, 143 illustrations. New York. D. Van Nostrand Company, 1937. Price $6.00.

This book announces the fact, "Seeing is more than a visual function." To vision it would add other "visual sensory processes": Neural pathways and activities; pupillary phenomena; the eyelids; orientation and convergence; binocular vision; accommodation; sensation; perception; color vision. These are the subheadings of chapter 3. Chapter 1 is headed "Seeing," and takes up the evolution of vision, learning to see, light and brightness out of doors, seeing in modern civilization, and argues that seeing is more than vision. Chapter 2, "The human seeing-machine," considers visibility and human beings, various thresholds of seeing, optimum conditions for seeing, correlations and controllable factors in seeing. Chapter 4 is headed "visual thresholds" and occupies 42 pages. Then the following chapters: 5, Visibility of objects; 6, Physiological effects of seeing; 7, Conservation and achievement; 8, Light and lighting; 9, Prescribing light; 10, quality of lighting; 11, Spectral quality of light; 12, Reading as task; 13, Eyesight and seeing.

These headings indicate only in outline the contents of the book. The authors—director and physicist at the Research Laboratory of the General Electric Company at Nela Park, Cleveland—stand high in the engineering profession. They have considered their subject from a standpoint quite different from that of the practicing ophthalmologist. But it is worth a great deal for those who can, to see their daily routine of work from a new standpoint. To read this book and think about it, will be helpful to all real teachers of ophthalmology; and we must all be teachers of the art of seeing, to our patients. To read these chapters should be suggestive to every advanced student-practitioner of ophthalmology. It is surprising to learn how much there is of ophthalmology, beside minute anatomy, nerve physiology, surgical detail, medical diagnosis, prescribing glasses, and modern therapeutics. Preventive medicine will need all the help that science can give.

Edward Jackson.

ABSTRACT DEPARTMENT

EDITED BY DR. WILLIAM H. CRISP

Abstracts are classified under the divisions listed below, which broadly correspond to those formerly used in the Ophthalmic Year Book. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is only mentioned in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. General methods of diagnosis
2. Therapeutics and operations
3. Physiologic optics, refraction, and color vision
4. Ocular movements
5. Conjunctiva
6. Cornea and sclera
7. Uveal tract, sympathetic disease, and aqueous humor
8. Glaucoma and ocular tension
9. Crystalline lens
10. Retina and vitreous
11. Optic nerve and toxic amblyopias
12. Visual tracts and centers
13. Eyeball and orbit
14. Eyelids and lacrimal apparatus
15. Tumors
16. Injuries
17. Systemic diseases and parasites
18. Hygiene, sociology, education, and history
19. Anatomy, embryology, and comparative ophthalmology

1

GENERAL METHODS OF DIAGNOSIS

Baratta, O. **Pupillometric experimental research of anisocoria in chronic appendicitis.** Ann. di Ottal. 1937, v. 65, Jan. p. 51.

The author made exact pupillary measurements in fifty patients definitely suffering from chronic appendicitis. Anisocoria was present in 88 percent of the cases examined in dim diffused light. Applying cocaine then in the weakest concentration, anisocoria was demonstrated in 80 percent of these following the mydriasis. The author concludes that this constitutes an important adjunct in diagnosis of the disease. The monocular dilatation disappears in from 12 to 25 days after the appendectomy. The right-sided dilatation is ascribed to the irritation of the sympathetic nerves on that side. (Bibliography) Park Lewis.

Bogoslovskii, A. I. **The relation between conditioned and unconditioned sensory reflexes in man.** Viestnik Opht., 1937, v. 10, pt. 5, p. 726.

The objective of the study was to determine the reaction between a negative conditioned reflex and a positive unconditioned reflex. The negative conditioned reflex was a diminished sensitivity to light in response to the beat of a metronome. The conditioning process consisted in sounding the metronome one minute preceding and one minute after the test subject entered the dark room. After repeated sittings the diminished light sensitivity brought on by entering a dark room was elicited by the sound of the metronome alone. Once established, this negative sensory reflex persisted for some days without further training. The unconditioned reflex used was increased light sensitivity in response to bright illumination. When simultaneously with the sound of the metronome the eyes were stimulated with intense light the reaction was a composite of the usual positive reaction and the conditioned negative reaction. As the conditioned negative reflex is being lost the positive unconditioned response to light rises. Both types of reflex are influenced by subjective states, such as psychologic suggestion. The indicator of these reflexes was the electric reaction of the eye. The author finds three types of reaction: the unconditioned reflex, the conditioned

reflex, and the reaction connected with conscious participation of the test person. He believes that the three types of reaction emanate from different portions of the cortex.

Ray K. Daily.

Bücklers, M. **Albino-hair colors.** Klin. M. f. Augenh., 1937, v. 98, April, p. 531.

Complete universal albinism is transmitted by recessive heredity. More frequently are encountered individuals whose eyes, skin, and hair contain more or less pigment. The hereditary propagation of this incomplete albinism is in no way definitely clear. In investigating the hereditary conditions of these types not only the eyes (color of iris and fundus), but also the skin and hair must be considered. Therefore Bücklers has devised six test bundles of hair, using the following colors: bluish-white, greenish-white, pinkish-white, and yellowish-white. These test bundles are obtainable at an address given.

C. Zimmermann.

Colenbrander, M. C. **New test types for determination of vision.** Klin. M. f. Augenh., 1937, v. 99, Aug., p. 213.

The author used the minimum visible for determining the visual acuity. After many experiments he constructed a schematic clock. It consists of a ring, a small disc in the center, and a triangle outside of the ring which is combined with a pointer to the central disc. The tip of this pointer is the detail which determines the visibility. Uniformity, variability in twelve positions, compactness, and simplicity are claimed as advantages, although the designation is not so easy as that of letters. (Illustration.) C. Zimmermann.

Fine, Max. **A simple illuminating device for gonioscopy with the binocular microscope.** Amer. Jour. Ophth., 1937, v. 20, Sept., pp. 943-944.

Grolman, von G. **Bitemporal hemianopsia in myopia.** Arch. de Oft. de Buenos Aires, 1937, v. 12, May, p. 240.

Attention is called to the pitfalls in campimetry, particularly in myopia, in which bitemporal hemianopsias have led to errors in diagnosis and to unverified suspicion of suprasellar syndromes. Higher myopia of the nasal fundus has been found a factor in one of the three cases reported, and the condition is regarded as due to a more pronounced staphyloma on the nasal side or to ophthalmoscopically invisible retinal lesions on that side, and related to the blind-spot enlargements (not necessarily corresponding to the peripapillary atrophy) also observed in myopia. M. Davidson.

Kentgens, S. K. **A new adaptometer for clinical use.** Arch. f. Augenh., 1937, v. 110, July, p. 492.

The author's adaptometer is equipped with a Hefner lamp emanating a standard of light and which reflected from an unalterably illuminated surface gives one lux or 100 millilamberts illumination. By placing graded photometric glasses, framed in a movable rake, between the illuminated surface and the observer, the illumination can be reduced to any amount between 100 and 0.0001 ml. and the intensity of illumination directly read off. The patient wears a mask which can be attached at the same time to the adaptometer to exclude all the outside light, so that no dark room is necessary.

R. Grunfeld.

Niemeyer, Waldemar. **Value of campimetry in chorioretinitis.** Primeiro Congresso Brasileiro de Opht., São Paulo, 1936, pp. 89-91.

The author completes the examination of cases of chorioretinitis with very careful recording of visual fields. He believes this is a more accurate way of recording the changes in the eyeground than any other, such as sketches or fundus photography.

Ramon Castroviejo.

Oloff, Hans. **A simple lantern apparatus for practical examination of disturbances of red-green and blue-yellow senses, including the color thresholds and testing the light sense.** Klin. M. f. Augenh., 1937, v. 99, Aug., p. 216.

The essential point in the construction of this lantern, which is described in detail and illustrated, is that it enables one to vary and measure graduations of size, luminosity, and saturation of the color surfaces, including equations of two color fields and exact determination of the thresholds of all colors. It also facilitates adaptation tests of the light sense. C. Zimmermann.

Siotto, Giovanni. **The metachromatic granules of Dold in xerosis bacillus.** Rassegna Ital. d'Ottal., 1936, v. 5, Nov.-Dec., p. 732.

Siotto isolated eighteen strains of xerosis bacilli from different eyes and developed them on Löfflers' serum. He then stained the slides from each group for six consecutive days, using the differential stain of Dold and Neisser. He found practically no difference in the percentage of cases showing metachromatic granules when using both of these stains and concludes that Dold's method is no more reliable or helpful than the simpler Neisser stain.

Eugene M. Blake.

Zamenhof, A. **Ophthalmoscopy in focal and indirect light.** Arch. d'Opht. and Rev. Gén. d'Opht., 1937, v. 1, n.s., June, p. 481.

By superimposing a +32 D. quadrilateral lens in the beam of light from the simplified Gullstrand binocular ophthalmoscope, a horizontal band of light about 5 mm. wide is formed. This "focalizer" can be raised or lowered, as well as moved laterally, and this permits a band illumination of vitreous and fundus which the author has found to be very useful in his studies, permitting him to study surface elevations and depressions by direct and indirect light. (Illustrations.) Derrick Vail.

2

THERAPEUTICS AND OPERATIONS

Alvaro, M. E. **Butilamino-acid-benzoic-dimethylaminoethyl-esther-monochloride as an anesthetic in ophthalmology.** Primeiro Congresso Brasileiro de Opht., São Paulo, 1936, pp. 83-85.

The author discusses briefly the advantages of pontocaine over cocaine.

Ramon Castroviejo.

Arguello, D., and Pereira, R. F. **The use of sodium evipan in ophthalmic surgery.** Arch. de Oft. de Buenos Aires, 1937, v. 12, April, p. 177.

Attention is called to the importance of age and general condition rather than weight of the individual in the matter of dosage. It is a circulatory depressant and dangerous in persons over sixty years of age. Slight mydriasis rather than miosis accompanies the anesthesia of evipan. Hepatic disease, diffuse peritonitis, severe anemia, shock, and coma are also contraindications. The rapidity of the anesthesia, its brief duration, and freedom from operative and postoperative discomfort are advantages, further enhanced by simultaneous use of novocaine-adrena-

lin anesthesia. No accidents have been experienced by the writers.

M. Davidson.

Ashbel, D. **The intensity of the ultraviolet rays in Palestine.** Folia Ophth. Orientalia, 1937, v. 2, Feb., p. 295.

The author enumerates data gathered concerning the amount of ultraviolet rays falling upon various parts of Palestine. The intensity of ultraviolet rays in general is very great there. To attain a skin-erythema dose a sun-bath of fifteen to twenty-five minutes' duration suffices at noon in summer, and an hour in winter. The intensity of the rays decreases with the distance of the locality from the sea-shore, but at the mountain tops the intensity equals that of the sea-shore.

R. Grunfeld.

Barkan, O., and Maisler, S. **Adrenalin chloride in one percent strength in ophthalmology.** Calif. and West. Med., 1937, v. 46, Mar., p. 150.

The authors report beneficial effect in one hundred cases of iritis and secondary glaucoma due to uveitis. They recommend the drug as a most effective substitute for the suprarenin products in ophthalmology.

Theodore M. Shapira.

Casa, G., and Mura, F. **Methyl-octenyl-amin in ocular diagnosis and therapeutics.** Boll. d'Ocul., 1937, v. 16, Feb., pp. 238-246.

This synthetic product has the commercial name of Octinum with a spasmolytic action. It has the power of relaxing the nonstriated muscular fibers which are in hypertonic state. Having tried its action by instilling it in the conjunctival sac of rabbits and in patients affected by spasm of accommodation resulting from overcorrected myopia, and comparing its action with that of other drugs with similar or antagonistic action, the author concludes that it is a good mydriatic of short duration; does not totally abolish the pupillary reflex to light and convergence, or the accommodative power; and is well adapted to treat spasm of accommodation. (Bibliography.)

M. Lombardo.

Chordas, S. M. **Electrothermometry of the eye.** Viestnik Opht., 1937, v. 10, pt. 5, p. 708.

A tabulated report of the temperature of the eyeball in one hundred cases of ocular disease shows the greatest rise of temperature in diseases of the iris and in keratitis with hypopyon. The temperature in perforating injuries varied with the extent of the iris involvement. In diseases of the conjunctiva (even with pannus) and in acute glaucoma the rise was insignificant. In herpetic keratitis the temperature was below normal.

Ray K. Daily.

Friede, Reinhard. **Removal of soft cataracts and cortical remains by suction; use of same instrument in hyphema, hypopyon, and keratoplasty.** Zeit. f. Augenh., 1937, v. 92, July, p. 201. (See Section 9, Crystalline lens.)

Karbowski, Mieczyslaw. **Adrenalin ionization in ophthalmology.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 247.

The author points out that adrenalin ionization is more effective and less disagreeable than subconjunctival or retrobulbar injections. The action of adrenalin depends on the normal calcium-potassium blood ratio, and in cases of calcium deficiency adrenalin ionization may be ineffective. In such cases it should be preceded by calcium ionization.

Ray K. Daily.

Kessler, R. **Targesin.** Ceskoslovenska Ofth., 1937, v. 3, no. 1, pp. 27-29.

Targesin is a silver remedy applicable in 3 to 5 percent concentration in all cases of conjunctival inflammation with secretion, especially cases of blennorrhea of the newborn; also in adult cases for disinfection of the conjunctival sac before operation, as also for washing out the lacrimal sac. It does not produce argyrosis. A brownish discoloration appears after too long use or too strong dosage, but disappears a few weeks after discontinuing the drug.

G. D. Theobald.

Licheri, Giovanni. **Autohemotherapy and hyphema.** Rassegna Ital. d'Ottal., 1937, v. 6, Jan.-Feb., p. 62.

The author reviews the ocular conditions in which autohemotherapy has been used and the results obtained. He describes nine cases so treated: four of glaucoma, in three of which the hyphema appeared after iridectomy, one spontaneously; one of occlusion and seclusion of the pupil; five of cataract; one of vitreous hemorrhage, and one of luetic iridocyclitis. In only three of the cases was there rapid clearing of the blood from the anterior chamber.

Eugene M. Blake.

Magitot, A. **Ocular pain. Treatment by anesthesia of the sphenopalatine ganglion and by orbital injections of alcohol.** Ann. d'Ocul., 1937, v. 174, June, pp. 361-375.

Pain produced by keratitis, iritis, glaucoma, and other ocular conditions may be controlled by anesthetizing Meckel's ganglion or by intraorbital injections. In addition to the relief of pain there may also be decrease in photophobia, blepharospasm, and lacrimation. The various methods of application are given.

Anesthesia of Meckel's ganglion is produced either by intranasal application of Bonain solution (menthol, cocaine, and phenol) or by injecting novocaine and alcohol into the palatine canal. The latter procedure has in several cases been followed by necrosis of the maxilla. Intraorbital injections of novocaine and 40-percent alcohol can be made without damaging the optic nerve. There is occasionally a transient paralysis of the external rectus. In certain cases these procedures seem to bring about improvement in the ocular condition. In keratitis there may be some clearing of the cornea and in glaucoma there may be some increase in transparency. The possible mechanisms of the action are discussed.

John C. Long.

Martin, J. E. **Ophthalmic trephine scissors.** Brit. Jour. Ophth., 1937, v. 21, July, pp. 377-378.

The author describes the scissors as an aid in dissecting the flap before operation, and as comfortable in manipulation. By diminishing flexion of the user's wrist, the finer movements of the hand are freed from interference and impairment. The scissors are fully described as to size, structure, and so on. (2 figures.) D. F. Harbridge.

Nižetić, Zdravko. **Experiences with cyclotropin in diseases of the anterior segment of the eyeball.** Klin. M. f. Augenh., 1937, v. 98, May, p. 658.

Cyclotropin consists of urotropin 2.00, sodium salicylate 0.8, and caffein-sodium salicylate 0.2 in ampoules of 5 c.c. Its chief action is that of urotropin, with generation of formaldehyde, especially in acid media, and the germicidal salicylic-acid component. Sixteen cases are reported with favorable results from intramuscular injections.

The main indications are diseases of the anterior uveal tract, perforating injuries, cyclitis and iridocyclitis, and postoperative irritations and infections. Especially noteworthy were the cases of sympathetic ophthalmia after severe perforations. C. Zimmermann.

Nižetić, Zdravko. **Anesthesia by sodium evipan in ocular surgery.** Ann. d'Ocul., 1937, v. 174, June, pp. 375-386.

Sodium evipan was used as a general anesthetic in 115 ocular operations. Sixty-six of the operations were enucleations but the remainder included a wide variety of procedures. The anesthesia was very satisfactory in most cases and had the advantage that the anesthetist was out of the way of the operator. There were no serious complications. The technique of administration is as follows: 0.5 gm. of allonal is given as a preoperative sedative, using a 10-percent solution of sodium evipan. The drug is injected intravenously at the rate of 1 c.c. each 30 sections. After 2 or 3 c.c. has been injected the patient is usually asleep: 2 or 3 c.c. additional is injected and after a brief wait the operation may begin. The dosage in this series ranged from 2 to 10 c.c. Nizetic considers this drug a very valuable one in eye surgery and believes it to be the anesthetic of choice in retinal detachment work.

John C. Long.

Sabata, J. **Experiment in treating eye affections by subconjunctival injection of the patient's own blood.** Ceskoslovenska Ofth., 1937, v. 3, no. 1, pp. 23-27.

A number of patients were treated for various diseases with subconjunctival injection of their own blood. Of twelve cases of infectious ulcer, without regard to the microbes involved, only one case did not react favorably. Trachomatous pannus was cleared and vision improved. The treatment had no noticeable effect in inflammations of the sclera or iris and affections of the vitreous. G. D. Theobald.

Spaeth, E. B. **The use of mucous membrane in ophthalmic surgery.** Amer. Jour. Ophth., 1937, v. 20, Sept., pp. 897-907.

Szymanski, Jan. **A small cautery.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 268.

A description of a small cautery for use on the eyeball. (Illustrations.)

Szymanski, Jan. **A small interrupter.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 267.

Description of an interrupter attached to an electrolysis needle, permitting gentle interruption of the current. (Illustration.) Ray K. Daily.

Tommasini-Mattiucci, Arduino. **Contribution to nasal-nerve syndrome: a rare complication from local anesthesia.** Riv. Oto-Neuro-Oft., 1936, v. 13, Sept.-Oct., pp. 478-482.

A woman of 41 years had extirpation of the left lacrimal sac performed under the usual infiltration anesthesia with 2-percent solution of novocaine. A short time after the operation the skin of the corresponding upper lid, of the left side of the nose, and of the frontal region was completely anesthetic. The eye showed perikeratic injection and the cornea was totally opaque with small round epithelial erosions. The iris was of normal color, the pupil miotic, and the tonus normal. Six hours later none of the symptoms persisted. (Bibliography.)

M. Lombardo.

Vranova-Provaznikova. **Injections of alcohol in eye diseases.** Ceskoslovenska Ofth., 1937, v. 3, no. 1, pp. 16-20.

In many cases of painful glaucoma, retrobulbar injections of alcohol are well regarded, especially where nothing else remains but enucleation. The injections may require repeating. The procedure is so simple it can be performed in the dispensary. Good results are obtained in entropion; also in painful atrophied bulbs. G. D. Theobald.

Wagner, R. **New remedies in ocular therapy.** Ceskoslovenska Ofth., 1937, v. 3, no. 1, pp. 5-10.

The author evaluates several new remedies which have enriched ocular therapeutics in the past ten years. In the Olomouc eye clinic, good results in relieving pain in herpes zoster ophthalmicus were obtained through injections of the patient's own blood. Beneficial results in tuberculosis were observed from intravenous injections of allochrysin and gold. In optic nerve therapy, intramuscular injections of hypermanganese or manganese intravenously produced good results. The latter relieves pain in herpes zoster. The author emphasizes the results obtained from antivirus therapy for dacryocystitis, in either ointment or solution; as also in cases of hemangioma the benefits from perivascular injections of quinine urethane. G. D. Theobald.

3

PHYSIOLOGIC OPTICS, REFRACTION, AND COLOR VISION

Barbel, I. E. **Remarks on the Soviet edition of the Ishihara plates.** Viestnik Opht., 1937, v. 10, pt. 5, p. 684.

The author demonstrates that the Soviet edition is in no way inferior to the original Japanese edition.

Ray K. Daily.

Dimshitz, L. A. **Remarks on Vishnevskii's article "Light sensitivity in diseases of the uvea, retina, and optic nerve"** (see Amer. Jour. Ophth., 1937, v. 20, Aug., p. 857). Viestnik Opht., 1937, v. 10, pt. 5, p. 721.

The author defends the conclusions of his studies on binocular summation of dark adaptation. Ray K. Daily.

Doesschate, G. ten, and Fischer, F. P. **About perspective.** Arch. f. Augenh., 1937, v. 110, July, p. 397.

The authors contend that only the perspective drawings of a tridimensional object will elicit true space perception, while perspective drawing of a bidimensional space will not.

R. Grunfeld.

Flores da Cunha, J. **Unilateral myopia.** Primeiro Congresso Brasileiro de Opht., São Paulo, 1936, pp. 73-81.

The author reviews the literature as to frequency, age, sex, relation with other ocular affections, dioptric power, and inheritance; and records 24 cases.

Ramon Castroviejo.

Gallerani, Giovanni. **How to measure and correct hyperopia with a concave spherical mirror.** Ann. di Ottal., 1936, v. 64, Dec., p. 801.

The author has established the fact that a hyperopic eye of six diopters, not corrected by suitable lenses, may be made to see objects at an infinite distance behind the observer by means of a concave mirror having a curvature of 20 cm., placed at 8 mm. from the cornea, and functioning as a periscope. The reflected and refracted rays are so projected from distant objects in the rear that they may be seen as by the emmetropic eye. The values are based on the classic reduced eye of Listing and the rules and elaborate calculations of

Gauss. The varying degrees of hyperopia will necessitate in each case a determination of the curvature required in the mirror and the distance at which it should be placed before the cornea.

Park Lewis.

Herzau, W., and Ogle, K. N. **The difference in size of the images of both eyes in asymmetric convergence and its significance in binocular vision.** Graefe's Arch., 1937, v. 137, pt. 3, p. 327.

It is found that a high similarity of images as it occurs physiologically with geometric projection in asymmetric convergence has no influence upon binocular fusion and upon the perception of depth because they are compensated for by a secondary change in the relation of the size of the images. Absence of disturbances in binocular vision with high degrees of lateral convergence can therefore no longer be used as an argument against the significance of differences in the size of images from another source, specifically of aniseikonia in a narrow sense. H. D. Lamb.

Hughes, W. L. **Aniseikonia in emmetropia.** Amer. Jour. Ophth., 1937, v. 20, Sept., pp. 887-890.

Jeans, P. C., Blanchard, E., and Zentmire, Z. **Dark adaptation and vitamin A.** Jour. Amer. Med. Assoc., 1937, v. 108, Feb. 6, p. 451.

A new photometer and the technique for its use in the determination of ability to adapt to darkness is described. The intensity of the light with which the photometric readings are made is controlled by a rheostat which is calibrated in millifoot candles, permitting the results of one investigator to be compared with those of another. Of 23 children in an orphanage 35 percent had abnormal test results by the new technique and in a group of 37 local school children 19 percent were subnormal and 5 percent were borderline. These results confirm a previously reported survey. Several of the children were placed in the hospital on a daily intake of 5,000 to 6,000 units of vitamin A and promptly improved to normal adaptation. Other tests indicated 3,000 units of vitamin A as the daily requirement. (10 figures.) George H. Stine.

Kravkov, S. V. **The effect of an indirect light stimulus on the effect of a direct stimulus.** Acta Ophth., 1937, v. 15, pt. 1, p. 96.

A set-up for quantitative determination of the effect of illumination of one eye on the visual function of the other eye. The sensitivity of the right eye to contrasts was tested, while the visual field of the left eye was illuminated by a separate device. The conclusions are that the illumination of the left eye serves as an indirect stimulus to the right eye and increases its contrast sensitivity. The relative effect of the indirect stimulus increases with the increase in intensity of the direct stimulus until a definite intensity is reached, and after that the relative effect remains constant. When the intensity of direct stimulus is such that it alone exhausts the functional capacity of the visual cortex, no sphere of action is left for the indirect stimulus. Ray K. Daily.

Kravkov, S. V. **The influence of acoustic stimulation upon the color sensibility of a protanopic eye.** Acta Ophth., 1937, v. 15, pt. 3, p. 337.

The curves show increased color sensitivity in the blue portion of the spectrum, with negative response in the remainder. These findings indicate to the author that in the protanope there is no differentiation for the perception

of red and green; and they fail to support Hering's theory of a yellow-sensitive substance in the visual apparatus.
Ray K. Daily.

Lauber, Hans. **Enlargement of the erect ophthalmoscopic image in the emmetropic eye.** Graefe's Arch., 1937, v. 137, pt. 3, p. 434.

López Enríquez (Rev. Españ. Biol. 1934, v. 3, p. 139), measured the size of after images on a screen kept at the same distance from the observer as the light source. Lauber first measured the horizontal diameter of the blind spot projected upon a Bjerrum screen in each eye of three emmetropic individuals. After this the amount of the angle and the linear value of the horizontal diameter of the papilla were estimated, using an axis-length for the eye of 22 mm. Next a strong light behind a metal slit 1 mm. broad and having a length that could be changed at will to a fixed amount was employed. By each of the individuals examined this lighted slit was observed at distances of 15, 20, and 25 cm. so as to produce an after image of varying length. Then by means of the Comberg ophthalmoscope these after images of known length were projected upon the back of the eye so that the elongated slit formed the horizontal diameter of the papilla. By change of the length of the slit in the lantern and of the range at which the lighted slit was observed, the length of the after image could be so varied as to be kept exactly the same as the cross section of the papilla. By this method, the enlargement of the papilla was found to vary between 10.5 and 12.5 times when the image was erect.
H. D. Lamb.

Lindeman, Heinz-Olaf. **Can deficiency of color perception be remedied by neophan glasses?** Klin. M. f. Augenh., 1937, v. 99, Aug., p. 224.

While Birch-Hirschfeld and Schubert recommended neophan glasses in certain degrees of defective color perception, Velhagen Jr. found only a relatively slight percentage of correction by them of errors made without such glasses. To review these different opinions, Lindeman examined 1022 male and 94 female students. He found 83 males to have defects of color vision. These were tested without and with neophan by five different methods. None of the 83 passed one of the tests without essential error. Hence the author considers it improper and useless to recommend neophan glasses to a person with defective color vision of any category. C. Zimmermann.

Motolese, Alfonso. **Consideration and calculations on the total index of the lens.** Boll. d'Ocul., 1937, v. 16, February, pp. 176-197.

The writer considers the lens as formed by two diverging meniscuses including a converging lens. By calculations he demonstrates that the total index of the lens is greater than the index of the nucleus. He thus demonstrates the correctness of the theory of intracapsular accommodation, and that the total index has an average value between the cortical and the nuclear.
M. Lombardo.

Musylev, F. J. **The relation between visual acuity and the distance of the object.** Acta Ophth., 1937, v. 15, pt. 2, p. 216.

The objective of this investigation was to explain the Aubert-Förster phenomenon. The conclusions are that visual acuity is determined by the size of the visual angle subtended by the object; that the Aubert-Förster phe-

nomenon is caused by faulty technique, with failure to provide in the investigations a constant visual angle of the background; and that the Freeman phenomenon is due to excessive convergence. Ray K. Daily.

Nastri, F. **Clinical and dioptric research on a catadioptric optical image. (6th image of Tscherning.)** Ann. di Ottal., 1936, v. 64, Nov., p. 780.

The author, after having graphically followed the successive refractions and reflections of the central rays of a luminous bundle in the sixth catadioptric optical image, calculates mathematically that it must be formed in the immediate vicinity of the retina. He then concludes from numerous clinical observations that the projected sixth catadioptric image has a linear amplitude equivalent approximately to one half of the useful visual image. (Bibliography.) Park Lewis.

Nordenson, J. W. **The new theory of anastigmatic spectacle lenses.** (Comments on Ostwalt's reply to criticism of M. Sundqvist). Graefe's Arch., 1937, v. 137, pt. 2, p. 309.

Ostwalt based his objection to the criticism of Sundqvist on the optical system of the eye being periscopic. The present author presents arguments against this belief, and concludes that Ostwalt's objections to Sundqvist's criticism are feeble. H. D. Lamb.

Rössler, F. **A practical change of the trial frame.** Klin. M. f. Augenh., 1937, v. 99, July, p. 89.

At two opposite points on the movable ring of the trial frame a mark was cut, and the cylindrical lens inserted so that its axis corresponded to this mark, greatly facilitating the reading of the axis. C. Zimmermann.

Smaltino, Michele. **On a catadioptric ocular image.** Ann. di Ottal., 1936, v. 64, Nov., p. 738.

The author has studied one of the two catadioptric ocular images (fifth image of Tscherning), demonstrating mathematically that this image is formed in the substance of the crystalline lens a short distance from its posterior surface. It therefore does not reach the retina and is not perceived by the eye. (Bibliography.) Park Lewis.

Vishnevskii, H. A. **Reply to Professor L. A. Dimshitz** (see above). Viestnik Opht., 1937, v. 10, pt. 5, p. 724.

The author defends the accuracy of his technique in studies of light sensitivity. Ray K. Daily.

Wittwer, Werner. **Congenital atrophy of the retina as suppositional cause of axial hypermetropia.** Klin. M. f. Augenh., 1937, v. 98, April, p. 514.

Five cases of congenital blindness from atrophy of the optic nerve and retina coincided in refraction, as all ten eyes presented high axial hypermetropia (from +4 to +10 D.), whereas the corneal refractions were about normal. Careful examination with the slitlamp justified the conviction that the lenses of all five patients were normal. From these investigations and clinical and experimental observations by Hertel and Vogt it seems to follow that just as for volume of brain the cerebral proton, so for dimensions and shape of the retina and therefore as to longitudinal optical axis the proton of the retina is of determining importance. The axial hypermetropia seems at least partly to be in genetic relation to the proton of the retina in the sense of A. Vogt's theory. C. Zimmermann.

Wölfflin, E. **Further investigations on dark adaptation of the cones.** Klin. M. f. Augenh., 1937, v. 98, May, p. 621.

Wölfflin reports his numerous simultaneous tests of the light and form senses of the cones at progressive dark adaptations. The visual acuity must be such that the factor of the form sense remains the same and the necessary variations in intensity of illumination must be referred exclusively to different light sensibility. In over 100 examinations it was proved for the cones (which is still contested for the rods) that in normal eyes monocular equaled binocular threshold value, and that also cases existed, in which the binocular threshold value was essentially lower than the monocular and generally corresponded to half the monocular. Both types were of almost equal frequency. It was interesting in one patient to ascertain in early tests the first, and a few weeks later the second, type. This peculiar behavior can so far be only explained by the assumption that light sensation takes place in a central organ which is in relation to that of the other side. Whether the association paths come into action or not, summation or equality of the two values will result.

C. Zimmermann.

4

OCULAR MOVEMENTS

Caramazza, Filippo. **Influence of rachicentesis on paralysis or paresis of extrinsic ocular muscles.** Riv. Oto-Neuro-Oft., 1936, v. 13, Nov.-Dec., pp. 529-554.

One case is reported of right and one of left paralysis of the third cranial nerve, in patients (one being female) between 55 and 71 years of age. One of these cases was probably due to rheumatism, two to cerebral arteriosclerosis, and one to luetic meningo-encephalic radiculitis. The first three cases recovered after one or two lumbar punctures. A man of sixty years showed paresis of the left external rectus connected with cerebral arteriosclerosis, which improved after two lumbar punctures, and a woman of 22 years showed paresis of the right external rectus due to serous meningitis with papillo-retinal stasis which improved after lumbar puncture. Three female patients whose ages ranged from 18 to 63 years, affected by multiple paralyses (one being part of a syndrome of the orbital apex for a probable periostitis of luetic origin, the other a part of a Gradenigo syndrome), did not show any changes. In his discussion the writer states that lumbar puncture is to be performed in these cases whether connected or not connected with intracranial pressure or other causes, as the lumbar puncture, beside having a good effect in some of the cases, has also some importance in differential diagnosis as to location of the lesion, that is, whether of nuclear or peripheral origin. (Bibliography, 16 figures.) M. Lombardo.

Collenza, D., and Jabilonski, W. **Normal and abnormal relations of retinae in strabismus.** Boll. d'Ocul., 1937, v. 16, Feb., pp. 212-237.

In monocular strasbismus two cases showed normal retinal correspondence, seventeen showed an anomalous congruous relation, and three an anomalous incongruous relation. In alternating strabismus, five had normal retinal correspondence, 17 a congruous anomaly, and six an incongruous anomaly. Among the cases of convergent strasbismus seven showed normal corres-Jondence, 28 congruous anomaly and three incongruous anomaly. Among the cases of divergent strasbismus no case

had normal correspondence, six had a congruous anomaly, and six an incongruous anomaly. (Bibliography.)

M. Lombardo.

Kestenbaum and Novotny. **Dissociated paralysis of gaze.** Wiener klin. Woch., 1937, v. 50, Mar. 5, pp. 351-354.

There are four main types of associated lateral eye movements: (1) those elicited by other than visual sensual impressions (commands); (2) those elicited by visual impressions (fixing an object); (3) those elicited by fixation of a moving object; and (4) those elicited by passive turning of the head.

In a 14-year-old patient suffering from a grippal meningo-encephalitis with mainly pontine localization (paresis of the seventh and sixth nerves) a partial paralysis of gaze to the right was found. Type 1 of the associated eye movements was completely paralyzed; type 2 markedly limited; types 3 and 4 normal.

Bertha Klien.

Lodberg, C. V. **Congenital absence of abduction.** Acta Ophth., 1937, v. 15, pt. 3, p. 247.

A detailed report of seven cases. From comprehensive review of the literature the author concludes that surgical treatment is not promising, and these cases are better left alone.

Ray K. Daily.

Ohm, J. **Nystagmus.** 42nd communication. Graefe's Arch., 1937, v. 137, pt. 2, p. 295.

Twenty-three albinos (18 male, 5 female) varying in age between 5 and 51 years, were investigated as to nystagmus. Some of the cases presented all types of nystagmus (pendulum movements, jerking motion to right, same to the left, and complicated oscillations), others only some of these or a single kind. The pendulum and jerking movements may vary in frequency in different cases. In general, the energy of the jerking nystagmus is considerably greater than that of the pendulum nystagmus.

H. D. Lamb.

Strebel, J. **Improvement of Prince's method of advancement.** Klin. M. f. Augenh., 1937, v. 98, June, p. 762.

After reprinting Haab's modification of Prince's method, Strebel describes with illustration his own procedure, in which he uses two black and two white sutures to avoid entanglement, combining the original traction method of Prince with spreading of the tendon according to Haab. The first vertical black suture is carried with a curved needle through the conjunctiva, subconjunctival tissue, and uppermost layer of the sclera near the limbus. In the same manner and 2 or 3 mm. lateral to this the white vertical suture is passed with a flatter needle. A doubly-armed black suture is introduced immediately behind de Wecker's double hook from above inward through the tougher tendinous tissue of the freed muscle, and the upper black thread is tied to the vertical anchor suture. The white sutures are prepared in the same manner and are tied simultaneously with the last black knot. The spreading white sutures may be varied for correcting a coëxisting cyclophoria or hyperphoria as illustrated by a case here recorded. The good eye was left free on the third day but covered by an opaque corneal shell, with a transparent area forcing fixation outward and downward. (Illustrations.)

C. Zimmermann.

Traina, S. **A case of petrositis with a large rarefaction at the apex, paralysis of the abducens, absence of pain, and**

exaggerated drowsiness; recovery. Riv. Oto-Neuro-Oft., 1937, v. 13, Sept.-Oct., pp. 449-455.

Twenty days after mastoidectomy a girl of thirteen years affected by left purulent otitis media showed paralysis of the sixth cranial nerve of the same side. After about two months, when the purulent focus at the apex of petrous bone had completely drained, the paralysis disappeared. The writer emphasizes the symptomatic axiom that profuse otorrhea and late abducens paralysis are exponent of suppuration process at the petrous apex. (2 figures.)

M. Lombardo.

Weckert. **The strabismus sheath, a method of relieving squint amblyopia.** Klin. M. f. Augenh., 1937, v. 99, Aug., p. 245.

The author has devised a sheath which is fitted to the spectacle frame, covering the whole orbital margin, so that vision of that eye is completely excluded. C. Zimmermann.

5

CONJUNCTIVA

Bucalossi, Antonio. **Hematologic investigations in trachoma.** Folia Ophth. Orientalia, 1937, v. 2, Feb., p. 313.

The author made a comparative study of the differential white-cell count of blood from the finger-tip of trachomatous persons with the white-cell count of blood taken from their conjunctiva. Among the persons examined twenty were afflicted with trachoma in the follicular stage and thirty in the cicatricial stage. The blood taken from the finger-tip of both groups and from the conjunctiva of the cicatricial group frequently showed marked decrease in neutrophiles with compensatory increase in lymphocytes, monocytes, and eosinophiles. The white cell count of the follicular group, however, showed an even greater decrease in neutrophiles. On the basis of these findings the author considers trachoma as a chronic inflammatory process to which lymphatic subjects are predisposed. R. Grunfeld.

Cuénod and Nataf, R. **New experimental research in trachoma.** Ann. d'Ocul., 1937, v. 174, July, pp. 433-450.

The geographic distribution of trachoma is roughly similar to that of typhus. With this clue lice were inoculated in the anus with trachomatous material. Rickettsia organisms multiplied greatly in the louse intestine and could be transferred by anal inoculation in pure culture through a series of lice. Typical trachoma developed in one human subject after inoculation with the intestinal content of the infected louse. Follicles developed in the conjunctiva of the monkey when similarly treated. The authors believe that trachoma is due to one of the rickettsia group, that lice serve as reservoirs for the disease and that lice may be one of the vectors of the virus.

John C. Long.

Custodis, Ernst. **Essential shrinking of the conjunctiva in the human eye.** Graefe's Arch. 1937, v. 137, pt. 3, p. 364.

Graefe's essential conjunctival shrinking or Stellwag's syndesmitis degenerativa is a special disease which has no relation to chronic pemphigus. The disease may extend over years and may remain confined to the eyes. Nevertheless it may also involve the mucous membrane of the mouth, pharynx, and larynx. In contrast to chronic pemphigus, essential shrinking of the conjunctiva is not accompanied by any apparent constitutional disturbances. Pathologico-anatomically in the eye, a

chronic inflammation occurs principally in the subepithelial tissue of the conjunctiva and results in hypertrophy of the connective tissue. The same chronic inflammatory process is observed in the connective tissue of the lacrimal gland, the tear passages, the episclera, the orbital fat, the extraocular muscles, and the skin of the eyelid. The disease begins where the formation of folds prevails in the eyelids, particularly in the medial lid-fold as well as in the fornix. The process is more intense in the conjunctiva where transition from one kind of epithelium to another occurs or where a fold is observed in the mucous membrane. Contraction of the newformed subepithelial connective tissue leads to shrinking of the tissues. Vesicular formations in the diseased conjunctiva are not like the vesicles of pemphigus but are cysts which arise through closure of the excretory ducts of the lacrimal gland or of the accessory lacrimal gland. In addition, through more intensive infiltration, superficial defects or loss of epithelium may take place or, by extension of the subconjunctival inflammatory process into the epithelium, vesicular formation or the remains of vesicles may be simulated. The etiologic factor in essential shrinking is a disturbance in the hormones of one or more endocrine glands producing an endotoxin from the stomach and intestinal canal. H. D. Lamb.

Derkač, V. **Treatment of trachoma by arresting secretions.** Klin. M. f. Augenh., 1937, v. 99, Aug., p. 229.

For social-hygienic reasons every lacrimation and secretion in trachoma patients must be treated as early as possible, to prevent new or secondary infections. The author uses as a disinfectant chlorine in 2-percent irrigation, followed by application of 1 or 2-percent nitrate of silver. In the afternoon 1 or 2 drops of airol in glycerin are instilled. Twice a day for ten minutes, applications of resorcin in 2-percent solution are made. As an anesthetic after the cauterizations with nitrate of silver 2-percent novocaine is recommended. Intramuscular injections of magnesium sulphate in 20-percent solution, which acts as a hypertonic solution, are a powerful aid in arresting secretions.

Federici, Ermanno. **Prophylaxis and therapy of gonococcic conjunctivitis.** Boll. d'Ocul., 1937, v. 16, Feb., pp. 141-152.

In the new-born and in adults the writer uses as a prophylactic a 20-percent solution of argyrol beside other local treatment. In 153 cases of developed infection in patients from two days to fifty years of age he used instillation of 10-percent argyrol solution every hour, hot or tepid compresses for a half-hour three times daily with a weak solution of salicylic acid, and further, in adult patients and severe cases, 2 c.c. of milk injection every day or two or a gonococcic vaccine intravenously. (Bibliography.) M. Lombardo.

Gala, A. **Conjunctival pemphigus.** Bratislavske Lekarske Listy, 1937, v. 17, June, pp. 257-261.

Inflammatory symptoms were slight. The condition was more marked in the left eye. The right eye showed symblepharon, with contraction of the conjunctival sac by cicatricial conjunctiva, and a pseudopterygium affecting the upper half of the cornea. In the left eye there was complete coalescence of the bulbar and palpebral conjunctiva, limiting motility. The epiglottis showed related changes, but there were no cutaneous manifestations. This is the only

case seen at the clinic among 100,000 cases in the course of eighteen years.

W. H. Crisp.

Gala, A. **Contribution to the therapy of conjunctivitis. "Hexargan," new silver-nitrate ointment.** Bratislavske Lekarske Listy, 1937, v. 17, July, pp. 317-320.

The ointment contains 1.3 percent of silver nitrate in an ionized form, combined with hexamethylentetramin and in a eucerine base. The ointment is well tolerated and has a marked bactericidal action, and may be used in acute and chronic inflammations of a bacterial character. W. H. Crisp.

Gowen, G. H. **The rate of disappearance of bacteria from the skin of the normal eyelids and the normal conjunctiva.** Ill. Med. Jour., 1937, v. 71, Mar., p. 216.

Experiments with B. prodigiosus showed that the skin of the eyelids disinfected itself of 99 or 100 percent of applied test organisms in twenty to thirty minutes. This is due to the acid reaction of the skin. The conjunctival sac disinfects itself in the same time by mechanical removal and bacteriolytic quality of the conjunctival fluids.

Theodore M. Shapira.

Green, John. **Mucous-membrane transplant in recurrent pterygium.** Amer. Jour. Ophth., 1937, v. 20, Sept., pp. 942-943.

Hasler, W. T., and Spekter, L. **Artificial fever in the treatment of gonorrheal ophthalmia.** Jour. Amer. Med. Assoc., 1936, v. 107, July 11, p. 102.

Six patients having gonorrheal ophthalmia were treated with hyperthermia, and in five the organisms disappeared after one or two treatments. In the sixth case the gonococci disappeared one week after the second treatment. The authors feel that this method is especially indicated when corneal complications are present. Recovery is speeded. (2 figures.)

George H. Stine.

Hynie, J. **New remedies recommended in trachoma therapy.** Ceskoslovenska Ofth. 1937, v. 3, no. 1, pp. 10-16.

Remedies discussed include colloidal iodin, yatren (iodin), and benzyl-cinnamon oil. G. D. Theobald.

Julianelle, L. A., Morris, M. C., and Harrison, R. W. **Studies on the infectivity of trachoma. 7. Further observations on filterability of the infectious agent.** Amer. Jour. Ophth., 1937, v. 20, Sept., pp. 890-896.

Koppich-Oláh, Lidia. **The treatment of trachoma.** Klin. M. f. Augenh., 1937, v. 99, Aug., p. 234.

The author reports on her experiences within one year with the local treatment of trachoma with trachoid. She finds this to be an important new remedy. It rapidly reduces the pannus, diminishes its tendency to relapse, speedily cures lesions of the cornea, abbreviates the duration of the trachoma, and is efficacious in cases in which other procedures have failed. (Illustration.)

C. Zimmermann.

Levkoeva, E. F. **Pathologic anatomy of folliculosis.** Viestnik Opht., 1937, v. 10, pt. 5, p. 666.

A detailed report of microscopic findings of scrapings and biopsies in folliculosis. The author is of the opinion that cytologically and histologically folliculosis and trachoma present different pictures. Usually differentiation can be made cytologically, except in rare cases in which the cytology of folliculosis

closely approaches that of trachoma in the first stage. In these cases the differentiation can be made by a biopsy.

Ray K. Daily.

MacCallan. **Trachoma as a virus disease.** Rev. Internat. du Trachome, 1937, v. 14, Jan., p. 5.

The author states that trachomatologists have now abandoned the bacterial etiology of trachoma and are obliged to consider it as a virus disease. He gives a classification of virus diseases and discusses the nature of viruses, methods of demonstration in morbid material, and modes of transmission. He discusses briefly the control of virus diseases. In regard to the contagion of trachoma, he states that in general stages 1 and 2 are contagious, that stage 3 is contagious in its early form but probably not later, and that stage 4 is not contagious.

J. Wesley McKinney.

Madroszkiewicz, M., and Przybylkiewicz, Z. **Preliminary communication on the experimental inoculation of trachomatous material into the brain and vitreous of animals.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 327.

The authors' work failed to confirm Szily's experimental studies (see Amer. Jour. Ophth., 1937, v. 19, p. 264). The meningeal changes described by Szily were not found after inoculation of trachomatous material into the brains of animals. Ray K. Daily.

Pascheff, C. **Granulomatous symmetric hyperplasias of the conjunctiva in fungoid mycosis (granuloma fungoides).** Klin. M. f. Augenh., 1937, v. 99, July, p. 64.

A man of 49 years died from severe fungoid mycosis. In the last few months of life there were symmetric metastatic hyperplasias of the conjunctiva, the histologic conditions of which are described in detail. In clinical symptoms, evolution, and histologic structure the process resembled fungoid granuloma. Implantation of the fungoid granuloma into the anterior chamber of rabbits caused only slight changes. Bacteriologically small cocci were seen isolated and in chains. (Illustrations.)

C. Zimmermann.

Postkowski, Ludwic. **Early diagnosis of trachoma.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 329.

A review of the literature, and the suggestion that follicular conjunctivitis is a misnomer and should be eliminated from the nomenclature of ocular diseases. Ray K. Daily.

Seefelder, R. **Further contribution to the eye changes in Besnier-Böck's disease.** Arch. f. Augenh., 1937, v. 110, July, p. 415.

The fingers of both hands of a 21-year-old boy showed clubbing at the basal phalanges, with sharply demarcated ulcers of the skin at the bases of the third and fourth fingers of each hand. After removing the crust, flesh-colored granulations were seen at the bases of the ulcers. X-ray examination revealed cystoid rarefaction of the bone-shafts resembling Jüngling's multiple cystoid tuberculosis. The lungs showed no sign of tuberculosis, but the lymphatic system was involved. The upper and lower retrotarsal folds of both eyes were diffusely reddened, swollen, and studded with yellowish red follicular nodules extending like a string of pearls over the bulbar conjunctiva. Biopsy of the nodules showed that they had been formed by epithelial-cell infiltration containing numerous giant cells of the Langhans type. They contained peculiarly stratified calcium concrements

such as are commonly found only in tuberculous changes. A tuberculous etiology of Böck's sarcoid is further bespoken by the common association of this disease with chronic nodular iritis.
R. Grunfeld.

Skydsgaard, Henning. **A case of phacocele.** Acta Ophth., 1937, v. 15, pt. 3, p. 343.

A report of a case of gonorrheal ophthalmia with a corneal perforation in which was jammed the lens. The lens capsule eventually ruptured, the lens was extruded, and the eye recovered with a leucoma and corrected vision of 5/60. (Illustrations.) Ray K. Daily.

Španić, Andrija. **A rare case of unulcerated conjunctival sclerosis of the lower fornix, semilunar fold, and globe.** Zeit. f. Augenh., 1937, v. 92, Aug., p. 300.

The author describes one eye with primary syphilitic lesion without ulceration. He excised some tissue for histologic study and also inoculated some into the anterior chamber of a rabbit. Herbert Haessler.

Spanić, Andrija. **Contribution to the knowledge of luetic inflammations of the conjunctiva.** Graefe's Arch., 1937, v. 137, pt. 2, p. 312.

In a 37-year-old man infected with lues in 1918, the tarsal conjunctiva of both eyelids of the right eye was thickened and infiltrated, and presented mild papillary hypertrophy. The same condition was present in the conjunctiva of the fornices, where grayish-yellow nodules were also observed. Similar nodules occurred in the proximal third of the tarsal conjunctiva of the upper eyelid and at the ends of the tarsal conjunctiva of the lower eyelid. In the middle and deep layers of the corneal parenchyma were opacities and also superficial and deep blood vessels. The opacities were punctate, flake-like, and partly confluent. Precipitates on the back of the cornea pointed to an iritis. Treatment for trachoma and for the iridocyclitis as if nonspecific proved useless. A piece of conjunctiva from the inferior fornix examined histologically showed epithelioid and giant cells, deeply placed. Repeated Wassermann blood tests were negative. Nineteen days after the beginning of antiluetic treatment, all the ocular symptoms had subsided. H. D. Lamb.

Strebel, J. **Dominant inheritance of pterygium.** Klin. M. f. Augenh., 1937, v. 99, July, p. 35.

The genealogic tree of a family shows dominance of inheritance of pterygium in three generations. (Illustration.)
C. Zimmermann.

Szymanski, J. **Additional examinations in the diagnosis of trachoma.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 321.

A review of histologic, cystologic, and biomicroscopic studies on the differential diagnosis of trachoma.
Ray K. Daily.

Thierry, J. H. **Contribution to elucidation of the etiology of phlyctenular affections.** Acta Ophth., 1937, v. 15, pt. 3, p. 355.

On the basis of the number of patients affected with phlyctenular conjunctivitis and with pediculosis capitis, the author concludes that the latter is one of the causes of the former.
Ray K. Daily.

Zamenhof, Adam. **The use of the loupe in examination of trachoma.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 336.

The author points out that in the absense of a slitlamp a loupe with a magnification of ten allows very thorough examination of the cornea.

Ray K. Daily.

6

CORNEA AND SCLERA

Angius, Tullio. **Disc-like opacity of the lens with circumscribed opacity of the cornea.** Rassegna Ital. d'Ottal., 1937, v. 6, Mar.-Apr., p. 168. (See Section 9, Crystalline lens.)

Baltin, M. M., and Serebrianni, Z. M. **Treatment of herpetic keratitis with Bucky's border rays.** Viestnik Opht., 1937, v. 10, pt. 5, p. 688.

From the results of 104 cases of herpetic keratitis treated with Bucky's ultrasoft rays the author concludes that properly administered this therapeutic procedure shortens the duration of the attack and deserves wide application. The best results are obtained in early cases, and therefore the treatment should be instituted promptly. In deep corneal involvement this treatment is ineffective. The merits of the procedure are painlessness, harmlessness, and the simplicity and rapidity of its administration. Ray K. Daily.

Busacca, Archimede. **The first stages in the development of trachomatous pannus studied with the biomicroscope and histologic sections.** Arch. d'Opht. and Rev. Gén. d'Opht., 1937, v. 1, n.s., April, p. 308, May, p. 402, and June, p. 505.

This monograph discusses the correlation of biomicroscopic and histologic findings in the pannus of trachoma. The author believes that pannus is a corneal defense reaction against and contemporary with the conjunctival infection. When the defense measures are insufficient, stimulation which the infection produces on the vessels determines their progression. A description of developing pannus and the associated histologic picture is given The article does not lend itself to abstracting. (Illustration, bibliography)

Derrick Vail.

Cavara, Vittoriano. **Primary adiposis of the cornea.** Boll. d'Ocul., 1937, v. 16, Jan., pp. 1-38.

A woman of 51 years showed at the temporal side of the right cornea a yellowish spot of five months' duration. It had an irregular outline, was surrounded by a grayish halo and newformed blood vessels, was slightly elevated, and was accompanied by intense iritis. A woman of 61 years showed a similar spot in the upper section of the left eye, without halo or inflammatory symptoms. In each case the corneal lesion developed in an apparently healthy cornea. The blood chemistry of the patients revealed the presence of neutral fats and an increase of neutral and acid fats following a fatty meal. Biopsy of a disc of the affected cornea in the first case showed fat elements between the lamellae, in the lamellae, in the normal epithelial cells, and in some long and round cells between the lamellae. No cellular elements were visible in the second case. A third patient affected by trachomatous pannus showed similar spots affecting the upper section of each cornea, evidently secondary to the corneal lesion. The article concludes with a lengthy discussion of primary and secondary corneal adiposis. Medical treatment is of no avail, and only radiotherapy can arrest the disease, changing the original lesion into scar tissue. (Bibliography, 12 figures.)

M. Lombardo.

Falcão, E. de C. **Corneal ulcer and maxillary sinusitis.** Rev. de Ophth. de São Paulo, 1937, v. 5, Feb., pp. 133-136.

The patient, a man of forty years, suffered for three years from a corneal ulcer which resisted all ordinary means of treatment, but responded rapidly to opening, curettement, and drainage of the maxillary sinuses by the technique of Caldwell-Luc. The cure has been maintained for seven years.

W. H. Crisp.

Federici, Ermanno. **Herpes corneae and Horner's syndrome.** Rassegna Ital. d'Ottal., 1937, v. 6, Jan.-Feb., p. 3.

After accidental entrance of tobacco dust into the conjunctival sac, a 34-year-old woman developed corneal herpes. As this condition improved there appeared a narrowing of the palpebral fissure, an enophthalmos of 2 mm. and a contracted pupil. Inoculation of rabbit corneas produced herpetic keratitis but no evidence of sympathetic disturbance. Numerous cases of herpes and of Horner's syndrome are reported from the literature. The author suggests that possibly the virus of herpes travels along the nasal branch of the ophthalmic nerve, attacking the sympathetic fibers. The fact that Federici's patient was pregnant may have had a bearing on the sympathetic disturbance, since cases of Horner's syndrome complicating pregnancy have been reported. (2 figures.) Eugene M. Blake

Filatov, V. P., and Bajenova, M. A. **Culture of dried corneal tissue.** Arch. d'Opht. and Rev. Gén. d'Opht. 1937, v. 1, n.s., May, p. 385.

After describing the technique of their experiments, the authors conclude that (1) the dried cornea loses 76.3 percent of its initial weight; (2) that the cornea, dried to a constant weight, is capable of growth, i.e. conserves its vitality; (3) that growth of the dried cornea compared with that of fresh or corneal tissue preserved by cold, manifests itself a little later (48 hours); (4) that among the elements of dried cornea, is discovered the growth of epithelium and fibrocytes, thus differing from fresh or preserved cornea. The practical bearing on corneal transplantation is obvious. (Bibliography, illustrations.)

Derrick Vail.

Filatov, V. P. **Remarks concerning the amelioration of leucomas and corneal transplantation.** Viestnik Opht., 1937, v. 10, pt. 5, p. 635.

The author applies the term amelioration to a method of implanting normal corneal tissue into the leucoma, in order to insure transparency of the subsequent corneal transplant. Clinical and anatomic observations convince the author that the prognosis relative to transparency of transplants is determined by the number of healthy corneal fibers in the host eye. To provide a favorable soil for a transplant in a dense leucoma he first makes a series of peripheral transplants, the final transplant being made in the center. Another method is that of thinning the leucoma with a Graefe knife and grafting on its surface a layer of clear cornea.

Ray K. Daily.

Friede, Reinhard. **Penetrating optic autokeratoplasty with scar-rotation.** Arch. f. Augenh., 1937, v. 110, July, p. 426.

Presenting eight new cases of autokeratoplasty with rotation of the disc at 180 degrees, in addition to the nine cases described four years ago, the author reviews the results of his operations. Autokeratoplasty with disc rotation must always be penetrating, and

should be performed on eyes having an old scar in the center of the cornea but a sufficiently broad and clear marginal zone, so that the clear portion shall constitute half of the disc. Best results were obtained with discs 6 to 7 mm. in size. Cross sutures anchored in the conjunctiva at the equatorial region held the rotated discs in place. The sutures have to be removed within 48 hours, otherwise opacities may form. Larger discs (8 to 11 mm. in diameter) involved numerous complications; these discs had to be fastened with corneal sutures. That autokeratoplasty is superior to homokeratoplasty is attested by the following comparison. In Elschnig's series the cures were 21 percent clear and 23.5 percent translucent discs; in Filatow's series 14.7 percent clear and 7.3 percent translucent. Against these stand the author's results, 69 percent transparent and no translucent discs. However, even a clearly transparent disc does not always improve the vision. The author considers improving his technique by using a comparatively long but only 3 to 4 mm. broad flap, and punching it out with a die aided by a matrix placed in the anterior chamber.

R. Grunfeld.

Grafova, Kornelia. **Recurrent angioneurotic edema of the cornea.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 237.

A review of the literature, and detailed report of two cases with angioneurotic manifestations and eosinophilia, but negative general organic findings. The corneal edema was unilateral, involved the center of the cornea, was more marked in the morning, and was not accompanied by lowered corneal sensibility, increased ocular tension, pain, or marked visual disturbance. For these reasons the author regards it as an angioneurosis and not as an inflammatory process.

Ray K. Daily.

Hanum, Stun. **Peculiar formation in the anterior chamber in a case of circumscribed parenchymatous keratitis.** Acta Ophth., 1937, v. 15, pt. 3, p. 351.

After recovery from an attack of circumscribed deep keratitis in the eye of an adult farmer, there was seen in the anterior chamber a cobweblike formation attached to the corneal opacity left after the disease. The author believes that this formation represents atrophied fibrinous membrane. Ray K. Daily.

Hofe, K. vom. **Neuralgia of the fifth nerve in inflammatory disease of the sclerotic.** Klin. M. f. Augenh., 1937, v. 98, May, p. 634.

Of 46 cases none showed certain evidence of lues. Thirteen women and five men had scleritis, 16 women and 12 men episcleritis. Five patients observed during the last two years complained of intense pain which could not be explained by the local changes of the sclerotic but suggested simultaneous inflammation of the peripheral branches of the fifth nerve. Both affections were considered as symptoms of an acute unknown infection. C. Zimmermann.

Iglei, H. **The treatment of pannus with scarlet-red ointment.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 344.

The author is very enthusiastic as to the effect of 6 to 8-percent scarlet-red ointment on pannus. Ray K. Daily.

Klar, R. **A contribution to the pathogenesis of corneal herpes.** Zeit. f. Augenh., 1937, v. 92, July, p. 215.

Statistical analysis of the cases of corneal herpes observed in the Bonn clinic from 1926 to 1935 showed a peak in

January to March and again in September to November. The 669 cases revealed a greater morbidity in the middle years of life, and twice as many males were affected as females.

F. Herbert Haessler.

Krol, A. G. **Therapy of parenchymatous keratitis.** Viestnik Opht., 1937, v. 10, pt. 5, p. 696.

Analysis of 224 case histories shows that specific treatment has a deciding influence on the course of the disease and the earlier the treatment is instituted the better the result. Good results are obtained by intensive therapy with mercury, iodides, arsenic, and bismuth. Recurrences are thus practically eliminated. Results are better in patients under fifteen than in older patients. Atropin is used locally and when instillation is ineffective atropin ionization produces dilatation of the pupil and separation of synechiae. Heat is indispensable, affording improvement in subjective symptoms and promoting resorption of exudates. Ray K. Daily.

Madroszkiewicz, Marian. **Remarks on early pannus.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 325.

A report of biomicroscopic studies of the limbus in eighteen eyes. In four cases of advanced trachoma there was no pannus. Of ten cases of doubtful trachoma, there was pannus in two cases which eventually developed into frank clinical trachoma. One case without pannus also developed into definite trachoma. The other seven cases recovered without cicatrization. Pannus was discovered in one of three cases of chronic conjunctivitis, after having been overlooked under the usual examination. In a case of swimming-pool conjunctivitis the cornea was normal.

Ray K. Daily.

Marzinkovskii, A. P. **A new knife for the amelioration operation.** Viestnik Opht., 1937, v. 10, pt. 5, p. 641.

A description of a double-edged knife for the purpose of cutting corneal flaps. (Illustrations.) Ray K. Daily.

Modrzewski, Tadusz. **The treatment of trachomatous pannus with massage of the lids.** Klinika Oczna, 1937, v. 15, pts. 2-3, p. 351.

Detailed report on a number of trachoma patients treated medically, surgically, and by a combination of surgery and medicaments. The author concludes that in addition to these procedures massage is a very useful therapeutic aid, materially shortening the course of the disease. Ray K. Daily.

Paternostro, Vincenzo. **On megalocornea.** Ann. di Ottal., 1936, v. 64, Dec., p. 846.

Clinically and pathogenetically three cases of megalocornea of the familial type, one associated with corectopia, were studied by the author. After reviewing the various theories on the genesis of this condition and evaluating the embryologic factor, he concludes that megalocornea could be produced from an abnormal differentiation of the marginal part of the secondary optic vesicle. (Bibliography.) Park Lewis.

Pick. **Treatment of degenerative corneal disease.** Zeit. f. Augenh., 1937, v. 92, July, p. 230.

In one patient who had a typical rosacea keratitis complicated by a degenerative lesion of the cornea in a patient with endocrinopathy, the author successfully usel Vogan, a preparation rich in vitamin A. He has since used it with benefit in other corneal lesions.

F. Herbert Haessler.

Riesenkampff, J. **Trachoma and serpent ulcer.** Klin. M. f. Augenh., 1937, v. 99, Aug., p. 247.

Three cases of serpent ulcer of the cornea in trachoma patients over fifty years old were cured by applications of Greifswald staining fluid and hourly optochin-scopolamin instillations, illustrating the very favorable prognosis in such sases. C. Zimmermann.

Russo, Antonio. **Experimental argyrosis of the cornea.** Rassegna Ital. d'Ottal., 1937, v. 6, Jan.-Feb., p. 72.

Russo performed a large series of experiments on rabbits' eyes to determine which layers of the cornea were involved in argyrosis. In the first group silver nitrate 1 percent or one of the silver albuminates was instilled into the conjunctival sac daily over a long period. In the second group scarification of the cornea was practised before instilling silver salts. The epithelium was scraped from the cornea in the third group, chloroform used to irritate chemically in the fourth group, and the fifth group treated with chloroform in olive oil. The author found the biomicroscopic picture of argyrosis thus obtained substantially the same as that of argyrosis produced by internal medication. Histochemically it was shown that Descemet's membrane presented a special electivity for silver impregnation. (2 figures.) Eugene M. Blake.

Salzer, Fritz. **Contributions to keratoplasty. 5. The biology of corneal transplantation.** Orch. f. Augenh., 1937, v. 110, July, p. 450.

In higher animals the transplanted tissue or organ does not remain intact for a long time, but soon undergoes slow decomposition. At the same time, as the result of the natural regenerative tendency of the wound margins, newformed tissue elements from the neighboring host-tissue intrude into this substance and gradually replace it. One must however be careful to guard the transplanted tissue from infection or inflammation, otherwise a cicatricial mass will form. Regeneration of corneal wounds originates from the spindelcells lying densely below the corneal epithelium, called keratoblasts, which intrude into and replace the transplanted corneal disc. The fixed stroma cells do not take part in the regenerative process. That the corneal substitute must originate from the epithelial layer is consistent with the newer embryological conception, which does not hold firmly to the specificity of the germinal layers. It is of no consequence whether one uses discs from the same species, or from widely different ones, for even dead material kept in conserving fluid has been successfully transplanted. It is only important that the transplanted tissue shall always be soaked with a nutritional fluid capable of preventing putrefaction. For a successful transplantation it is necessary further that the leucoma shall contain well preserved corneal parts from which regeneration may proceed. Total, adherent vascularized leucoma forms an unsuitable bed for a transplant.

R. Grunfeld.

Salzmann, Maximilian. **The intrascleral epithelial cyst.** Zeit. f. Augenh., 1937, v. 92, Aug., p. 275.

Salzmann describes his clinical experience as to five eyes afflicted with this rather rare lesion, and histologic preparations from three of them. The cysts resulted from proliferation or implantation of superficial epithelium into the sclera after trauma in the region of the limbus. All occurred in childhood or early puberty. Usually the laceration

was produced by a blunt or jagged agent such as an arrow or stick of wood. Such cysts develop months or years after the patient has been discharged as healed. Growth is not uniform and is more rapid circularly than radially, so that an originally oval cyst becomes kidney-shaped or multilocular. The cyst is white like the sclera, and is thus distinguished from intercalary staphyloma in this region. It is easily transilluminated and sharply circumscribed. On section one finds the space lined with epithelium. When the eye is blind, enucleation is indicated. If there is a chance of retaining some vision, the anterior wall must be excised but not covered with conjunctiva, the latter being brought to the edge of the exposed epithelium on the posterior cyst wall.

F. Herbert Haessler.

Smaltino, Michele. **Contribution to the knowledge of corneal degeneration in trachoma.** Boll. d'Ocul., 1937, v. 16, Jan., pp. 126-138.

The history is given of five female patients affected by old trachoma with recurrent pannus. Their age varied from 19 to 42 years. The cornea of either one or both showed a whitish-yellow spot which started at the limbus and proceeded toward the center of the cornea and in one case on to the sclera. These spots were elevated and were covered by blood vessels. The spots were removed for examination and were seen to have reformed some time later. Histologic examination of the removed tissue showed in the pannous subepithelial tissue and in the underlying lamellae masses of hyalin degeneration. (Bibliography, 11 figures, 5 colored.)

M. Lombardo.

Strebel, J. **Objective proofs of the curative orthopedic effect of contact glasses in keratoconus.** Klin. M. f. Augenh., 1937, v. 99, July, p. 30.

These proofs can be established by exact measurement of the central corneal radii and by direct and indirect measurement by means of the light images. The clinical history of a carefully analyzed case of keratoconus illustrates favorable functional and anatomic results of merely orthopedic treatment by contact glasses, which cannot be obtained by operation. The contact glass acts like a supporting orthopedic corset, and produces by fixation ample vascularization with disappearance of the opaque streaks of the conus, the lids exerting a constant massage by pressure. C. Zimmermann.

Terrien, F. **The value of indirect light on the study of fine precipitates on Descemet's membrane** Arch. d'Opht. and Rev. Gén. d'Opht., 1937, v. 1, n.s., June, p. 501.

Applying a small transilluminator perpendicularly to the cornea, previously anesthetized, permits the observer to see fine precipitates on Descemet's membrane which otherwise might have escaped notice and which are important in differentiating primary from secondary glaucoma. (Illustration.) Derrick Vail.

Urrets Zavalia, A., Allende, I. M., and Oliva, R.O. **Scleromalacia in the course of chronic porphyrinuria.** Klin. M. f. Augenh., 1937, v. 99, Aug., p. 189. (See Amer. Jour. Ophth., 1937, v. 20, Oct., p. 1080.)

Velter, S. L. **Clearing of an opaque transplant after repeated transplantation.** Viestnik Opht., 1937, v. 10, pt. 5, p. 643.

A report of three cases with opaque transplants which became transparent

after additional transplantations of corneal tissue. (Illustrations.)

Ray K. Daily.

Vogt, A. **The keratoconus lines of the conical apex and their anatomic basis.** Klin. M. f. Augenh., 1937, v. 98, May, p. 577.

In very thin optical sections of the conical apex of keratoconus Vogt found three typical, sharply separated changes; (1) the vertical keratoconus lines in the deep parenchyma; (2) the keratoconus stripes and opaque bands of Bowman's membrane and the adjacent most superficial parenchyma, which occur later than the lines; (3) the tear of Descemet's membrane and opacities and tear glass lines close to it (late symptoms) as well as the star-shaped scars of the conical apex. Clinical and histologic description of the keratoconus lines are given in detail. They are of remarkable constancy and may remain for years, are mostly vertical, and are parallel. In later stages also horizontal lines were observed. Histologic examination showed that Vogt's original designation as fissure lines was not correct. The corneal tissue of the keratoconus apparently is pathologic, perhaps a yielding to intraocular pressure. The investigations of genealogic trees in the last two decennia make it probable that hereditary genes are the basis of keratoconus. (Illustration.)

C. Zimmermann.

7

UVEAL TRACT, SYMPATHETIC DISEASE, AND AQUEOUS HUMOR

Bürki, E. **On pupillotony.** Klin. M. f. Augenh., 1937, v. 99, Aug., p. 145.

Eighteen cases of pupillotony are reported in detail. It is described as an independent clinical picture which has no etiologic connection with lues. It is a harmless affection which frequently has been mistaken for reflex immobility of the pupil. Thus a control of 123 cases recorded within the last eleven years in the Basel eye clinic as reflex immobility of the pupil revealed that sixteen were pupillotonies. The convergence reactions had not been sufficiently considered. In contrast with reflex immobility, pupillotony is mostly unilateral (80 to 90 percent). The pupil is oval, usually medium-sized or mydriatic, and reacts slightly or not at all to light, directly and indirectly, while the reactions to convergence and accommodation are tonic. Often there is partial or total atrophy of the pupillary margin. Differing from reflex immobility the pupil reacts promptly to cocaine, homatropine and pilocarpine. In 75 percent of the cases the etiology was not clear, but 75 percent of the patients were women. The tendon reflexes of the lower extremities were abolished in 50 percent. Exceptionally, myotonic pupillary reactions may be caused by lues of the central nervous system. If the fixation was unilateral the other pupil showed sluggishness or reflex immobility—atypical pupillotony.

C. Zimmermann.

Duc, Camillo. **Concerning synechiotomy.** Rassegna Ital. d'Ottal., 1937, v. 6, Mar.-Apr., p. 189.

This is a short article in which the writer endorses heartily the instrument devised by Guglianetti for cutting anterior synechiae. This is a double-edged blade, quite wide. It will sever tenacious iris bands with less risk to the lens and less trauma than other methods. The writer urges more extensive use of this instrument. Eugene M. Blake.

Frank, F. **The elements of heredity of the iris based on photographic studies.**

Folia Ophth. Orientalia, 1937, v. 2, Feb., p. 337.

Not alone the color of the iris, but any of the various structural elements of the iris stroma may be recognized as hereditary elements; such as form, configuration, number, and localization of the crypts; the shape of the collarette; thickness, density, and course of the individual fibers of the ciliary portion of the iris stroma; and color and distribution of pigment spots in the stroma. The most far-reaching similarity is found in uniovular twins. Sometimes hereditary elements are found in siblings which are not present in the parents but in the sidelines.

R. Grunfeld.

Johansson, Ernst. **On the etiology of iridocyclitis.** Zeit. f. Augenh., 1937, v. 92, June, p. 154.

The author points out that iridocyclitis may be a complication of latent phlebitis. The phlebitis usually involves the veins of the lower extremities, which are invaded at the time of other infections such as an angina.

F. Herbert Haessler.

Kessler, R. **Remarks on gold therapy in chronic iridocyclitis.** Ceskoslovenska Ofth., 1937, v. 3, no. 1, pp. 20-22,

Intramuscular injections of allochrysine were given to 27 cases at five to seven-day intervals in doses of 0.05 to 0.2 gm.; the total dosage being 3 to 5 gm. Improvement was noted as to sight and inflammation.

G. D. Theobald.

Knobloch, R. and J. **Fluorescein test for tissue resorption in case of vascular changes in the extremities.** Ceskoslovenska Ofth., 1937, v. 3, no. 1, pp. 45-52.

On the supposition that the faculty of resorption would be an important indicator of tissue vitality in judging therapeutic procedure in cases of gangrene of the extremities, these authors injected various coloring matters (fluorescein compound with sodium, indigo carmine, suprarenin phenolphthalein) subcutaneously and intramuscularly into different parts of the affected members. They then followed the rapidity of resorption between the injection time and the appearance of the coloring matter in the aqueous humor and in the urine. By comparing the elimination periods from the involved areas after the injections, they secured the index or resorption. When elimination took twice as long as normal, or even more than twice as long, especially in muscular areas, this was very important in prognosis, as showing that in the unaffected part of the extremities neither cautious or conservative exercise nor elevation of the parts gave any hope of success. G. D. Theobald.

Zolotareva, M. M., and Mar, G. I. **The properties of the aqueous humor.** Viestnik Opht., 1937, v. 10, pt. 5, p. 667.

A laboratory study to demonstrate the identity of the lysolytic properties of the aqueous humor and cerebrospinal fluid. The investigation consisted of determination of the lysolytic action of the aqueous of an ox on its ocular tissues, the action of human cerebrospinal fluid on human ocular tissues, and the action of pig-blood serum on the ocular tissues of the pig. The results show that the aqueous and the cerebrospinal fluid possess lysolytic properties, absent in blood serum. Lysis of ocular tissues was demontrated in the aqueous and in the cerebrospinal fluid. The effect of blood serum was negative in this respect. Ray K. Daily.

NEWS ITEMS

Edited by Dr. H. Rommel Hildreth
640 S. Kingshighway, St. Louis

News items should reach the Editor by the twelfth of the month

Deaths

Dr. John Dodds Flagg, Buffalo, died July 19, 1937, aged 77 years.

Miscellaneous

Greenville County in South Carolina has established an Association for the Blind during the past year. The work has been successful in placing these people well on the road to financial independence.

Societies

The following is a copy of the program of the Scientific Meeting of the Eye Section of the Philadelphia County Medical Society, which was held October 7, 1937, at 8:15 p.m. Dr. G. Gurley, presentation of clinical case from Wills Hospital; Dr. Bernard Samuels, Cornell University, Pathology of sympathetic ophthalmia; Dr. Edgar B. Burchell, New York, Methods and value of examining conjunctival secretions.

The Eye Section of the Philadelphia County Medical Society announces Postgraduate Conferences in Ophthalmology to be held on the first Thursday in the month. The time is 7:25 p.m., prior to each Scientific Session. Additional information may be obtained from Dr. Edmund B. Spaeth, Secretary of the Eye Section, 21st and Spruce Sts., Philadelphia.

Personals

Dr. Joseph W. Crawford has recently been made Assistant Clinical Professor of Ophthalmology at the University of California Medical School.

Dr. W. D. Horner and his wife are at present on a trip to Mexico where he has been attending a convention of the Pacific Coast Railway Surgeons.

Dr. C. Allen Dickey has been newly elected as Secretary-Treasurer of the Pacific Coast Oto-Ophthalmological Society.

Dr. Frank Rodin has just returned from an extensive trip abroad, during which time he visited the clinics at Vienna, Budapest, Paris, and London.

69%

OF THE PATIENTS WITH

ANISEIKONIA

HAVE HAD DEFINITE RESULTS

We have filled:

467 Prescriptions for Iseikonic spectacles.

428 Patients wore their Iseikonic correction and reported their results.

39 Patients have not reported in the last three months.

After due trial of temporary Iseikonic glasses,

296 pairs of permanent Iseikonic glasses were supplied (69%).

132 Patients returned their temporary glasses because of insufficient results.

Reprints and other information upon request

Guild of Prescription Opticians

A. HAUSTETTER, Inc.

Branch
855 Madison Ave.

2 East 45th St.
New York City

Columbia University
NEW YORK POST-GRADUATE MEDICAL SCHOOL

SHORT COURSES FOR OPHTHALMOLOGISTS

Motor Anomalies of the Eye. One week—January 10 to 15, 1938. Fee $50. Refraction and motor anomalies considered conjointly. Anatomy of the ocular muscles, nerve supply, action of individual muscles, anomalies of associated movements, anomalies of convergence, of divergence and sursumvergence. Lectures and case demonstrations. Minimum registration 15; maximum 35.

Short courses in the following subjects may also be arranged: Histology and Pathology of the Eye, Slit Lamp, Operative Surgery of the Eye, Ophthalmic Anatomy, Physiology of the Eye, Practical Refraction, Physiological Optics, Ophthalmic Neurology, Uveitis and Glaucoma.

Courses in Medical and Industrial Ophthalmology are offered to the general practitioner.

For application and further information, address
THE DIRECTOR
303 East 20th Street, New York, N. Y.

DEC 17

SERIES 3, Vol. 20, No. 12 DECEMBER, 1937

MEDICAL LIBRARY

AMERICAN JOURNAL OF OPHTHALMOLOGY

CONTENTS

		PAGE
Experimental and clinical exophthalmos	*George K. Smelser*	1189
Effects of anoxemia on ocular movements	*R. A. McFarland, C. A. Knehr, and C. Berens*	1204
Lighting standards	*W. B. Lancaster*	1221
Removal of lead shot from the vitreous	*W. E. Borley and E. Leef*	1232
The surgery of chronic glaucoma	*O. Barkan*	1237
Cataract surgery	*W. F. Moncreiff*	1245
Method of preparing a transparent eyeball	*H. R. Hildreth*	1249
Vision after glaucoma operation	*E. V. L. Brown*	1250

DEPARTMENTS

Society Proceedings	1252
Editorials	1259
Book Notices	1263
Abstracts	1265
News Items	1290
Index for Volume 20	i

For complete table of contents see advertising page V

Copyright, 1937, Ophthalmic Publishing Company, 640 South Kingshighway, Saint Louis, Missouri

Subscription price in United States ten dollars yearly. In Canada and foreign countries twelve dollars. Published monthly by the George Banta Publishing Company, 450 Ahnaip Street, Menasha, Wisconsin, for the Ophthalmic Publishing Company. Subscription and Editorial Office: 640 S. Kingshighway, Saint Louis, Missouri. Entered as second class matter at the post office at Menasha, Wisconsin.

WHEN THE HANDICAP IS TOO GREAT

even a champ can't win...

● No matter how good the athlete, if the handicap is too great he can't win. And so it is with the craftsmen who manufacture your prescriptions. No matter how great is their skill, they can't overcome the handicap of second quality raw materials so as to finish with a first quality prescription. A second quality lens is always second quality.

It is important that you *know* about the quality of lenses that are used in filling your prescriptions. Second quality "just as good" lenses should not be acceptable when you pay first quality prices or *nearly as much.*

To give you the confidence and self-assurance that comes only from *knowing* that the lenses you give your patients are the lenses you ordered, Roco Rx Service includes the original lens envelopes with every Orthogon, Soft-Lite and Balcor prescription. This is your protection. It safeguards your own good name. Send today's Rx's to your Riggs office. You'll experience a new satisfaction.

A FINISHED PRESCRIPTION IS NO BETTER THAN THE MATERIALS FROM WHICH IT IS MADE

RIGGS OPTICAL COMPANY

Distributors of Bausch and Lomb Ophthalmic Products

"She's a *Different* Girl"

Now she enjoys life, now she makes friends easily. Like simulated pearls, Gougelman eyes defy all but the closest and most expert inspection. Most of our patients go thru life without their friends being aware of any eye deficiency, such perfection bringing untold peace of mind and confidence to those so distressed. The country's leading eye physicians recommend Mager & Gougelman because most cases can be fitted immediately from our vast stock of 125,000 eyes (the most complete in the world) without delay or extra expense. Unusual problems are handled by artisans skilled in the making and fitting of special shapes and colors.

Where at all possible we recommend a visit by the patient to one of our offices. When this is impractical a selection of fifty or more eyes can be mailed on memorandum direct to the eye physician for fitting. Thru the use of color, size and shape charts, great accuracy is obtained and we shall be glad to furnish further information regarding this unusual service.

SHELL PROSTHESIS

Over Shrunken or Deformed Globes

Ordinary Shell — Improved Contact Shell

The advantage of contact shells is that the motion of the globe is identical with that of the sound eye and that no depression occurs under the upper lid in most cases. The Gougelman contact shell is made of exceptionally thin tempered material to conform as nearly as possible, to the curvature of the globe, thereby minimizing the possibility of irritation.

MAGER & GOUGELMAN, INC.

EASTERN DIVISION

NEW YORK
510 Madison Ave.

BOSTON
230 Boylston St.

PHILADELPHIA
1930 Chestnut St.

WASHINGTON, D.C.
311 Albee Bldg.

WESTERN DIVISION

CHICAGO
30 N. Michigan Ave.

DETROIT
805 Empire Bldg.

MILWAUKEE
710 N. Plankinton Ave.

KANSAS CITY
1105 Rialto Bldg.

CLEVELAND
913 Schofield Bldg.

PITTSBURGH
803 May Bldg.

ST. LOUIS
801 Metropolitan Bldg.

MINNEAPOLIS
325 Medical Arts Bldg.

That's the American Optical way

You can have your prescription made with every detail as you desire, in American Optical Laboratories. Temples that swing hard or easy . . centers that fit close to your patient's nose, or far out, as you wish.

That's because AO prescriptions are not just the bare interpretation of figures on a piece of paper. American Laboratory experts make a special point of studying your individual preferences. Each prescription is an artistic job, incorporating your ideas.

See your friendly American Branch Manager for further details. Tell him exactly what you want. Have **your** prescription made the way **you** want it.

AMERICAN OPTICAL
Laboratory Service